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Second Series.

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Part 14.—Report on the Acanthology of the Desmosticha. (Part III.) Further observations on the Acanthology of the Diadematidæ. By H. W. MACKINTOSH, M.A., M.R.I.A., Professor of Zoology, and Curator of the Museum of Anatomy and Zoology in the University of Dublin. (With Plates IX. and X.) [July, 1883.]

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PROCEEDINGS

OF

THE ROYAL IRISH ACADEMY.

SCIENCE.

PAPERS READ BEFORE THE ACADEMY.

I.—Report on the Flora of the Shores of Lough Erne. By Richard Manliffe Barrington, M.A., LL.B., F.L.S.

[Read, April 9, 1883.]

LOUGH ERNE is situated in Fermanagh, and extends through the centre of that county from one end to the other in a north-westerly direction. Its length is over forty miles, if we include the broad, sluggish river which connects its upper portion with the lower and larger sheet of water lying between Enniskillen and Belleek. Its width varies from six miles to less than half a mile, and in some places it assumes the appearance of a deep, slow river.. Its height above the sea level is about 150 feet. The difference between the level of the upper and lower lakes is only two feet, and this very slight gradient in thirty or forty miles causes the water of the River Erne to move with exceeding slowness. Its depth is perhaps greater than any lake in Ireland—reaching 226 feet in one spot. The waves are frequently large, and the navigation dangerous for small boats in rough weather. The islands vary from a few yards across to several acres in extent, and probably exceed one hundred; they are generally well covered with trees or low shrubs, and the scenery in some places resembles Killarney.

Promontories, inlets, and bays are so numerous that a guide is essential, especially through the upper lake. These windings enormously increase the extent of the shore line, and it perhaps reaches 150 miles in length. Its distance from the sea at Bundoran is about twelve miles at the nearest point.

The immediate neighbourhood of the lake is undulating ground, with marshy meadows in the hollows. Woods are common, and gentlemen's residences occur at intervals along the shore.

Shean North rises to the height of 1135 feet within one mile of the shore, between Derrygonnelly and Belleek on the lower lake, and from the upper lake, Knockninny, 628 feet in height, is about the same distance. With these exceptions, the land near the water's edge nowhere rises to any considerable height. None of the localities for species extend further from the lake than the cliffs of Shean North, at Pollaphuca, which are about half a mile distant.

The district is entirely limestone, except a portion of the east side, between Enniskillen and Kesh, where the new red sandstone borders the lake for about nine miles. Boa Island also belongs to the sandstone formation. Everywhere the rocks are deeply covered with boulder clay, and they are rarely, if at all, exposed along the shore.

As my examination of the flora did not extend more than half a mile inland, the species observed were mainly lowland forms. At Pollaphuca a few mountain species were gathered, eleven of which (marked with an asterisk) go to swell the species, which deviate from Watson's British and English types. These number only twenty-six, and are arranged after Watson's compendium of the "Cybele Britannica," 1870, thus:—

SCOTTISH.

*Gymnadenia albida.
Potamogeton filiformis.

SCOTTISH-HIGHLAND.

*Saxifraga hypnoides.
*Crepis paludosa.
Rubus saxatilis.

SCOTTISH-BRITISH.

Thalictrum majus (Sm.).
Vicia sylvatica.
Pinguicula vulgaris.
Parnassia palustris.

BRITISH-SCOTTISH.

Comarum palustre.
*Geum rivale.
Sparganium minimum.
*Habenaria viridis.
*Scirpus cæspitosus.
*Eriophorum vaginatum.

HIGHLAND.

Galium boreale.
*Hieracium iricum.

BRITISH-HIGHLAND.

Chrysosplenium oppositifolium.
Vaccinum myrtillus.
*Lycopodium selago.

HIGHLAND-INTERMEDIATE.

*Sesleria cærulea.

ENGLISH-GERMANIC.

Sium latifolium.
Œnanthe phellandrium.
Lemna gibba.

ATLANTIC-BRITISH.

Hypericum androsæmum.
*Lastrea æmula.

With the exception of the mountain species gathered on the side of Shean, all were collected between the lake level, 150 feet and 250 feet, or within a vertical range of 100 feet.

The great extent of shore made it impossible to go over all the ground, even at a rapid pace, and my examination of the district is not yet complete. Altogether I spent about three weeks there, from the 6th to the 11th August, 1881, and from the 10th to the 24th June, 1882; and the various localities examined were as follows:—

1881.

August 7, . .	Shore between Enniskillen and Rossclare.
„ 8, . .	Marshes near Oldcastle, Enniskillen, and Islands of Devenish, Trasna, &c.
„ 9, . .	Rabbit, Horse and Kinnausy Islands, and Gubbaroe Point, Kesh.
„ 10, . .	Belleek.
„ 11, . .	Belleek to Enniskillen, by road and shore.

1882.

June 10, 11, 12,	Camped on Devenish Island, of the flora of which I made a tolerably complete list.
„ 13, 14, .	White Island, Ferney, &c.
„ 15, . .	Ely Lodge and Castle Hume.
„ 16, . .	Owl, Goat, Gaffer, Namanfin and Gay Islands, from Blaney Bay.
„ 17, . .	Blaney Bay to Pollaphuca and Shean.
„ 18, . .	Owl Island, Namanfin and Gubbaroe, Kesh.
„ 19, . .	Blaney Bay to Bellisle on the upper lake.
„ 20, . .	Bellisle to shore near Lisnaskea.
„ 21, . .	Lisnaskea to Crum.
„ 22, 23, .	Crum.
„ 24, . .	Crum to Belturbet by river.

The method adopted was to gather a specimen of every species, no matter how common, and mark it off in my list each evening, as they were taken out of the vasculum one by one. All rarities and critical species, and many common ones, were then set aside and dried for examination at home.

During my second visit a boat was hired in Enniskillen, and I camped in a tent, brought for the purpose, on the various islands and portions of the shore I was desirous of exploring.

The district has, on the whole, been fairly productive of species; I have to report to the Academy the occurrence of 417—fifty-nine of which have not hitherto been recorded from District X. of the "Cybele Hibernica," to which Lough Erne belongs, nor have they been added in a Supplement to it, published by Mr. A. G. More, in 1872.

SPECIES NEW TO DISTRICT X.

Thalictrum majus (Sm.).
Caltha radicans.
Nasturtium sylvestre.
Saponaria officinalis.
*Sagina nodosa.
Stellaria glauca.
Geranium dissectum.
*Linum catharticum.
Euonymus europæus.
Trifolium medium.
Lotus major.
Vicia sylvatica.
Orobus tuberosus.
*Agrimonia eupatoria.
Rubus hemistemon (Müll.).
Rosa villosa.
*Rosa arvensis.
Epilobium palustre.
Sedum anglicum.
Pimpinella saxifraga.
Leontodon hirtus.
Sonchus asper.
Hieracium iricum ?
H. umbellatum.
Gentiana amarella.
*Myosotis cæspitosa.
Solanum dulcamara.
Centunculus minimus.
Samolus valerandi.
Chenopodium album.
Atriplex angustifolia.
Polygonum minus.
*Callitriche hamulata.
Salix capræa.
S. repens.
Anacharis alsinastrum.
Gymnadenia conopsea.
Habernaria bifolia.
*H. chlorantha.
*H. viridis.
Lemna trisulca.
L. gibba.
Potamogeton polygonifolius.
P. filiformis.
*P. zizii.
Scirpus pauciflorus.
*S. setaceus.
Carex elongata.
C. hornschuchiana.
C. lævigata.
*Phleum pratense.
Sesleria cærulea.
*Aira flexuosa.
Trisetum flavescens.
Glyceria plicata.
Catabrosa aquatica.
Festuca sciuroides.
Chara gracilis.
Nitella opaca.

The twelve species marked with an asterisk have been recorded by Mr. S. A. Stewart, who visited another portion of District X. in 1881.[1] Mr. Stewart did not approach the shores of Lough Erne, but confined his examination to the mountainous district of western Fermanagh and the adjoining portion of Cavan. His list contains 280 species, twenty-seven of which I did not observe, but of these more than one-half are mountain species not likely to occur on the shore of a lowland lake.

On the other hand, I noticed 164 species not recorded by Mr. Stewart. Combining both lists, and allowing a margin of 150 species for new records, the flora of the county Fermanagh consists of about

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[1] Proceedings, Royal Irish Academy, 2nd series, vol. iii. (Science), p. 531.

600 species, or a little more than half the Irish flora. The absence of *Papaver rhœas* from the west of Ireland is well known; but on the east coast, especially in parts of Dublin and Wicklow, it is the commonest of all weeds of cultivation.

Why is this species so rare in western Ireland? Its seeds are produced in thousands, and the facilities for its introduction in seed corn are evident.

The most interesting species observed were—*Caltha radicans*, *Carex elongata*, *Rosa villosa*, *Potamogeton filiformis*, *P. sizii*, *Rubus hemistemon*, *Hieracium umbellatum*, *Stellaria glauca*, and *Nasturtium sylvestre*.

Caltha radicans is new to Ireland, and its only British locality is in Forfarshire, where, I believe, it has not been found recently. My specimens want radical leaves and sepals; the latter were much narrower than in *Caltha palustris*, and fell off in the vasculum. *Rubus hemistemon* and *Potamogeton sizii* are also new to Ireland. The latter has been recorded by Mr. Stewart[2] since I gathered it in 1881. A few of the critical species were brought for comparison to the Herbaria of Cambridge and Kew, and I have to thank Professor Babington and Mr. J. G. Baker for looking over some of them. At the British Museum Mr. Carruthers gave me every facility for comparing critical species with the fine series of specimens there.

This report is not so complete as is desirable. To examine 150 miles of shore in three weeks with care was not possible, many islands and localities were unvisited. The district is not an unproductive one, and yet the negative results are numerous.[3] On a future occasion I hope to be enabled to present to the Academy a supplemental report, and institute a comparison between the Flora of the shores of Lough Erne and other Irish lake districts.

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[2] *Ib.*, p. 542.

[3] *Ranunculus auricomus*, *R. ficaria*, *Geranium molle*, *Peplis portula*, *Hippuris vulgaris*, *Cotyledon umbilicus*, *Œnanthe fistulosa*, *Daucus carota*, *Matricaria inodora*, *Scrophularia aquatica*, *Veronica agrestis*, *V. polita*, *V. anagallis*, *Teucrium scorodonia*, *Myosotis repens*, *Utricularia vulgaris*, *Rumex conglomeratus*, *Polygonum lapathifolium*, *Euphorbia peplus*, *Viola palustris*, and many other common species, were not seen. Neither were any species of the genera, Fumaria, Drosera, Silene, and Montia observed; but I hope to reduce the list on my next visit to Lough Erne.

[LIST OF SPECIES

LIST OF SPECIES.

Arranged for the most part after the 7th Edition of the London Catalogue of British Plants, 1881.

[Plants certainly not native are marked thus *; those possibly introduced †; and those probably introduced ‡].

Ranunculaceæ.

Thalictrum majus (Sm.), var. a. (Bab. Man.)—Rare. Only seen on Goat Island and at Gubbaroe Point, Kesh. Two or three specimens.

T. flavum (Linn.)—Rare. On Killygowan Island, Upper Lake.

Anemone nemorosa (Linn.)—Common.

Ranunculus pseudo-fluitans (Syme).—In the river at Belleek under the bridge. This is probably *R. peltatus* (Fries.), var. *penicillatus* of the Lond. Cat. But in the case of the Batrachian Ranunculi, I hesitate to identify the synonyms. After a careful examination of the British Museum series, I was much puzzled with some varieties.

R. heterophyllus (Fries.)—Wet ditches on Devenish Island, &c. These specimens somewhat resemble *R. baudotii* (Godr.).

[*R. confusus* (Godr.)—An imperfect specimen gathered in a drain one mile east of Crum Castle has been doubtfully referred to this variety by Professor Babington; but before extending the range of a plant so rare in Ireland,[4] and usually found on the coast, better specimens should be procured. At present it is included under *R. heterophyllus*.]

R. hederaceus (Linn.)—By no means common. Noticed three miles north of Enniskillen, on the east side, in 1881. Not seen in 1882.

R. flammula (Linn.)—Common.

R. lingua (Linn.)—By the lake one mile north of Enniskillen. Plentiful.

[*R. auricomus* (Linn.)—Probably escaped notice, owing to its early flowering.]

R. acris (Linn.)—Common.

R. repens (Linn.)—Common. Very luxuriant among the ruins on Devenish.

R. bulbosus (Linn.)—Certainly not common, and only observed at Crum Castle.

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[4] See T. H. Corry in Journal of Botany, 1882, p. 347.

[*Ranunculus ficaria* (Linn.)—Escaped notice, probably, as in the case of *R. auricomus.*]

Caltha palustris (Linn.)—Common.

C. radicans (Forst.)—In tolerable plenty on soft mud on the east side of Devenish Island, near the ruins. When first seen, it struck me as being a very unusual form of *C. palustris*, with almost deltoid leaves, narrow non-contiguous sepals, and rooting at the nodes. I have compared it with specimens from Forfarshire in the herbarium at Cambridge, and with the original figure in the Linnean Society's "Transactions," vol. viii., p. 323. It has been shown to Professor Babington, Mr. J. G. Baker, the Rev. W. W. Newbould, and others, all of whom consider it to be *C. radicans*. My specimens are not perfect—the sepals having fallen off in the vasculum—but they were much narrower than in ordinary *C. palustris*, and non-contiguous.

**Aconitum napellus* (Linn.)—Near Castle Hume, Lower Lake; outcast from garden.

NYMPHACEÆ.

Nymphæa alba (Linn.)—Not uncommon in various parts of the lake.

Nuphar lutea (Sm.)—Far commoner than the last.

PAPAVERACEÆ.

**Chelidonium majus* (Linn.)—On the walls of Crum Castle. Not a single specimen of any species of the genus Papaver was observed, thus confirming its known rarity in the west of Ireland.

FUMARIACEÆ.

[None of this family observed.]

CRUCIFERÆ.

Sinapis arvensis (Linn.)—Frequent.

Sisymbrium officinale (Scop.)—On Devenish and elsewhere.

S. alliaria (Scop.)—Not common. In the wood at Castle Hume, Lower Lake.

Cardamine pratensis (Linn.)—Common.

C. hirsuta (Linn.)—Common.

C. sylvatica (Link).—Frequent.

Barbarea vulgaris (Brown).—Occurs in several places. A specimen, with spreading and curved pods, gathered one mile north of Enniskillen, comes near *B. arcuata* (Reich.), which ought to be looked for.

Nasturtium officinale (Brown).—Common.

Nasturtium sylvestre (Brown).—A specimen, with the pods not sufficiently developed to decide with certainty, was gathered at Bellisle, Upper Lough Erne. It probably belongs to this species.

N. palustre (D. C.)—On Devenish Island and elsewhere. Frequent.

N. amphibium (Brown).—Common.

Capsella bursa-pastoris (Mœnch).—Common.

RESEDACEÆ.

Reseda luteola (Linn.)—Not common. East shore, lower lake.

VIOLACEÆ.

Viola sylvatica (Fries.)—Common.

V. canina (Auct.)—Frequent. On Devenish Island and elsewhere about Lough Erne.

V. eu-tricolor (Syme.)—Gathered at Gubbaroe Point, near Kesh. The flowers are almost as large as *V. lutea*. On the same sandy sloping pasture, which has no appearance of recent cultivation, grows *Centunculus minimus*.

V. curtisii (Forst.)—On the shore near Lisnaskea. This, and the former species have been named by Professor Babington.

[*V. palustris* (Linn.)—Not marked in my list, but has surely been overlooked.]

DROSERACEÆ.

None seen.

POLYGALACEÆ.

Polygala vulgaris (Linn.)—Common. A very fine form, almost *P. grandiflora* (Bab.), occurs on Ferney Island.

P. depressa (Wender).—Not uncommon in suitable places.

CARYOPHYLLACEÆ.

**Saponaria officinalis* (Linn.)—By the avenue on the side of the lake opposite the old castle at Crum.

[*Silene inflata* (Sm.)—Apparently wanting.]

Lychnis diurna (Sibth.)—At Gubbaroe Point, Kesh.

L. flos-cuculi (Linn.)—Common.

Cerastrium glomeratum (Thuil.)—Common.

C. triviale (Link.)—Common.

Stellaria media (With.)—Common.

S. holostea (Linn.)—On White Island and elsewhere not uncommon.

S. glauca (With.)—Quite plentiful in many places by the shore a few miles north of Enniskillen. It also occurs on the upper lake at Crum Castle, and probably elsewhere.

S. graminea (Linn.)—Common.

S. uliginosa (Murr.)—On Devenish, &c. Common.

Arenaria trinervis (Linn.)—Frequent.
Sagina procumbens (Linn.)—Common.
S. nodosa (Meyer).—About three miles north of Enniskillen, on east side of lake, but not common.
Spergula arvensis (Linn.)—Fields by lower lake.

PORTULACACEÆ.

[*Montia fontana* (Linn.)—Must occur, but not seen.]

HYPERICACEÆ.

Hypericum androsæmum (Linn.)—Frequent. Generally occurs as an isolated specimen here and there.
H. tetrapterum (Fries.)—On Devenish, &c. Common.
H. humifusum (Linn.)—Not common. Gubbaroe Point, Kesh.
H. pulchrum (Linn.)—Common.

MALVACEÆ.

**Malva sylvestris* (Linn.)—A single specimen only was observed near a cottage by the roadside, between Blaney Bay and Pollaphuca.

LINACEÆ.

Linum catharticum (Linn.)—On Devenish, &c. Common.

GERANIACEÆ.

Geranium dissectum (Linn.)—On Devenish, &c.; but not common.
G. lucidum (Linn.)—Among the ruins on Devenish.
G. robertianum (Linn.)—On Devenish, &c. Common.
[*G. molle* (Linn.)—Not seen. Mr. S. A. Stewart found *G. molle*, but not *G. dissectum*.]
Oxalis acetosella (Linn.)—On Devenish, &c. Common.

ILICACEÆ.

Ilex aquifolium (Linn.)—Ely Lodge, &c. Frequent.

CELASTRACEÆ.

Euonymus europæus (Linn.)—On the islands, and elsewhere in many places. Common.

RHAMNACEÆ.

Rhamnus catharticus (Linn.)—On the islands and shores of the lower lake. Common.

SAPINDACEÆ.

**Acer pseudo-platanus* (Linn.)—About Ely Lodge, &c. Planted.

LEGUMINIFERÆ.

Ulex europæus (Linn.)—Not so common as is usual in many parts of Ireland.
Medicago lupulina (Linn.)—Frequent.
Trifolium pratense (Linn.)—Common.
T. medium (Linn.)—Rare. Banks of the lower lake, near Castle Hume.
T. repens (Linn.)—Common.
T. minus (Relhan.)—Common.
Lotus corniculatus (Linn.)—Common.
L. major (Scop.)—Near Ely Lodge, &c. Not very uncommon.
Vicia cracca (Linn.)—Common, and generally distributed.
V. sylvatica (Linn.)—Only on the north end of Isle Namanfin, lower lake. Sparingly.
V. sepium (Linn.)—Frequent.
Lathyrus pratensis (Linn.)—Common.
L. palustris (Linn.)—Plentiful on the shore of Upper Lough Erne, near Bellisle House.
Orobus tuberosus (Linn.)—Common.

ROSACEÆ.

Prunus spinosa (Linn.)—Common.
P. avium (Linn.)—Many trees by the roadsides, between Blaney Bay and Pollaphuca.
Spiræa ulmaria (Linn.)—Very common.
Agrimonia eupatoria (Linn.)—Frequent.
Alchemilla arvensis (Scop.)—Rather rare. Seen only at Gubbaroe Point, near Kesh.
A. vulgaris (Linn.)—Frequent. Devenish, &c.
Potentilla fragariastrum (Ehrh.)—Common.
P. tormentilla (Schenk.)—Very common.
P. reptans (Linn.)—Rather scarce; seen very seldom.
P. anserina (Linn.)—Occurs in suitable places.
Comarum palustre (Linn.)—Frequent.
Fragaria vesca (Linn.)—Frequent.
Rubus idæus (Linn.)—Commoner about the lower lake than I have seen it elsewhere in Ireland.
R. saxatilis (Linn.)—On the shore in many places. Ferney Island, &c.
R. hemistemon (Müll.)—A bramble gathered on the shore opposite White Island in Lower Lough Erne has been identified by Prof. Babington as belonging to this variety, which is new to Ireland.

Rubus discolor (W. & N.)—This variety is I believe not uncommon, though no specimen was dried.

Geum urbanum (Linn.)—Common.

G. rivale (Linn.)—At Pollaphuca, White Island, &c.. Frequent on the west side of lower lake.

G. intermedium (Ehrh.)—On the north end of White Island with *G. rivale.*

Rosa spinosissima (Linn.)—This rose grows nearly all round the lower lake. On the shore of one of the little promontories, near Rossfad, I noticed a large round isolated bush, about four feet high. Its habit was so different from *R. spinosissima* that I showed the specimen gathered (in fruit) to Mr. J. G. Baker, at Kew, suggesting that it might be *R. hibernica.* Mr. Baker, however, pronounced it to be an inland form of *R. spinosissima,* and certainly not *R. hibernica.* An imperfect specimen of a rose gathered on the shore of White Island Mr. Baker was unable to identify, but added "see if *R. hibernica,*" which species should be looked for.

R. mollissima (Willd.)—Devenish Island. My specimen was named by Mr. Baker. There are two or three bushes. The leaves are very soft.

R. tomentosa (Sm.)—Common. Many forms of this species occur; some coming near to *R. mollissima.* White and red-flowered varieties seem pretty equally distributed, but I saw no intermediate colour. Mr. Baker considers one of my specimens as var. *scabriuscula;* the other varieties were not sufficiently perfect with fruit, &c., to identify positively.

R. canina (Linn.)—Common.

R. arvensis (Huds.)—Frequent.

Cratægus oxyacantha (Linn.)—Common.

Pyrus aucuparia (Gaert.)—Frequent.

LYTHRACEÆ.

Lythrum salicaria (Linn.)—Plentiful.

[*Peplis portula* (Linn.)—Not seen].

ONAGRACEÆ.

Epilobium hirsutum (Linn.)—Scarce. At Castle Hume and near Rossfad.

E. parviflorum (Schreb.)—Common.

E. montanum (Linn.)—Common.

E. obscurum (Schreb.)—Not uncommon.

E. palustre (Linn.)—Scarce. Three miles north of Enniskillen, on the east shore of the lake.

Circæa lutetiana (Linn.)—Very common in some places.

Haloragiaceæ.

Myriophyllum alterniflorum (D. C.)—Not common. In a ditch near Crum Castle.

Callitriche stagnalis (Scop.)—Frequent. This is *C. platycarpa* (Kütz.)

C. hamulata (Kütz.)—In a bog drain between Pollaphuca and Blaney Bay.

Another specimen of *Callitriche*, gathered in the same place, has not the fruit sufficiently developed, but it looks like *C. verna.*

Crassulaceæ.

Sedum acre (Linn.)—On walls, Enniskillen.

Saxifragaceæ.

Saxifraga hypnoides (Linn.).—Cliffs at Pollaphuca.

Chrysosplenium oppositifolium (Linn.)—Common.

Parnassia palustris (Linn.)—Trasna Island, &c., lower lake, but local.

Umbelliferæ.

Hydrocotyle vulgaris (Linn.)—Common.

Sanicula europæa (Linn.)—Common in suitable places.

Cicuta virosa (Linn.)—Rare. In a marsh at Crum Castle, upper lake.

Helosciadium nodiflorum (Koch.)—Common.

H. inundatum (Koch.)—Common.

**Petroselinum sativum* (Hoffm.)—On the walls of the old castle at Crum.

‡*Ægopodium podagraria* (Linn.)—Ely Lodge, &c.

Bunium flexuosum (With.)—Common.

Pimpinella saxifraga (Linn.)—Shores of the lower lake.

Sium latifolium (Linn.)—Plentiful near Enniskillen.

S. angustifolium (Linn.)—Near Enniskillen. Common.

Œnanthe crocata (Linn.)—Not unfrequent,

Œ. phellandrium (Linn.)—Common.

Angelica sylvestris (Linn.)—Common.

Heracleum sphondylium (Linn.)—Common.

[*Daucus carota* (Linn.)—Not seen].

Caucalis anthriscus (Gaert.)—Common.

Chærophyllum sylvestre (Linn.)—Common.

Conium maculatum (Linn.)—Devenish, &c. Common.

Araliaceæ.

Hedera helix (Linn.)—Common.

CAPRIFOLIACEÆ.

Sambucus nigra (Linn.)—Common.
Viburnum opulus (Linn.)—Very generally distributed.
Lonicera periclymenum (Linn.)—Frequent.

RUBIACEÆ.

Galium boreale (Linn.)—Common on the shores of most of the islands in the lower lake.
G. verum (Linn.)—Occurs in a few places round the lower lake.
G. saxatile (Linn.)—On Shean, near Pollaphuca.
G. palustre (Linn.)—Common.
G. aparine (Linn.)—Common.
Asperula odorata (Linn.)—Not common.
Sherardia arvensis (Linn.)—Not seen about the shores of the lower lake, but occurs at Crum Castle, on the upper lake.

VALERIANACEÆ.

Valeriana officinalis (Linn.)—Common. Devenish, &c.

DIPSACEÆ.

Scabiosa succisa (Linn.)—Very common.

COMPOSITÆ.

Carduus lanceolatus (Linn.)—Generally distributed.
C. palustris (Linn.)—Common everywhere.
C. pratensis (Huds.)—Common.

A curious plant, gathered near Bellisle House on the upper lake is perhaps a hybrid between *C. pratensis* and *C. palustris*, as both species were growing near. This hybrid is probably *C. forsteri* (Sm.): [see Bab. Man., 8th ed., p. 207.]

C. arvensis (Curt.)—Common.
Arctium intermedium (Lange.)?—On Devenish, &c. Not uncommon. The specimen is too young to determine with certainty.
Centaurea nigra (Linn.)—Common.
C. cyanus (Linn.)—Rare. At Rossclare, lower lake.
Crysanthemum segetum (Linn.)—In cultivated fields on east side of lower lake.
C. leucanthemum (Linn.)—Common.
**Matricaria parthenium* (Linn.)—On the Island of Trasna. Probably planted.
[*M. inodora* (Linn.)—Not seen.]
**Tanacetum vulgare* (Linn.)—On the island of Trasna. Probably planted.

Achillea millefolium (Linn.)—Common.

A. ptarmica (Linn.)—Common.

Artemisia vulgaris (Linn.)—Lower Lough Erne. Not common.

Gnaphalium uliginosum (Linn.)—Rather rare.

G. sylvaticum (Linn.) — Only seen at Gubbaroe Point, Kesh, sparingly in a field with *Centunculus minimus*.

Senecio vulgaris (Linn.)—Common.

S. sylvaticus (Linn.)—Rare. Near Crum Castle.

S. jacobæa (Linn.)—Frequent.

S. aquaticus (Huds.)—The commonest *Senecio*.

Bidens cernua (Linn.)—Not common. Near Crum Castle.

‡*Inula helenium* (Linn.)—Only seen on Devenish Island in one spot, at the end next Enniskillen. There is a colony of about twenty plants.

I. dysenterica (Linn.)—Common.

Bellis perennis (Linn.)—Common.

Solidago virga-aurea (Linn.)—Very generally distributed.

Tussilago farfara (Linn.)—Common.

Petasites vulgaris (Desf.)—Only seen near Castle Hume.

Eupatorium cannabinum (Linn.)—Blaney Bay, &c. Not unfrequent.

Lapsana communis (Linn.)—Common.

Hypochœris radicata (Linn.)—Frequent.

Leontodon hirtus (Linn.)—Scarce. Near Crum Castle.

L. autumnalis (Linn.)—Common.

Taraxacum officinale (Wigg.)—Common.

Sonchus oleraceus (Linn.) } Common. Devenish and elsewhere; per-
S. asper (Hoffm.) } haps *S. oleraceus* is the most frequent.

S. arvensis (Linn.)—Cultivated fields east side of lower lake.

Crepis virens (Linn.)—Rather a rare plant, but it was observed at both Upper and Lower Erne.

C. paludosa (Mœnch.)—Frequent about the west side of the lower lake.

Hieracium pilosella (Linn.)—Devenish, &c., but not common.

H. iricum (Fries.)?—Common on the limestone cliffs of Shean at Pollaphuca. The flowers on my specimens are not expanded.

H. umbellatum (Linn.)—On the north end of Isle Namanfin in the lower lake; among the stones on inundated ground, the roots forming a dense matted sod some yards square; from this the stems grow thickly, and rise about one foot high. A few scattered specimens about ten yards away grow to twice that height. Where the plant grew thickly, it had a very puzzling appearance, not being in flower. When dried, the flowerless stems have a slight resemblance to *Inula salicina*. Living specimens brought home are expected to flower this season, but a careful examination leaves little doubt that the plant is *H. umbellatum*.[5] If the living plants flower, all doubt will at once be removed.

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[5] See note at end of Paper.

CAMPANULACEÆ.

Campanula rotundifolia (Linn.)—Rossclare, &c. Not common.

ERICACEÆ.

Vaccinum myrtillus (Linn.)—Bilberry Island, &c. Frequent.
Erica tetralix (Linn.)—Over Pollaphuca, &c. Frequent.
E. cinerea (Linn.)—Near Pollaphuca, on the hill.
Calluna vulgaris (Salisb.) — Near Pollaphuca, lower lake, on the hill and elsewhere.

JASMINACEÆ.

Fraxinus excelsior (Linn.)—Common.
**Ligustrum vulgare* (Linn.)—Occurs in hedges near houses.

GENTIANACEÆ.

Erythræa centaurium (Pers.)—In many places.
Gentiana amarella (Linn.)—Apparently rare. I only gathered it on the shores of the lower lake.
Menyanthes trifoliata (Linn.)—Common. Occurs in great quantity on Devenish.

CONVOLVULACEÆ.

Convolvulus sepium (Linn.)—On the island of Trasna, and probably elsewhere.

SOLANACEÆ.

Solanum dulcamara (Linn.) — Single specimens occur on the shores near Gubbaroe, &c., but it is not common.

SCROPHULARIACEÆ.

Scrophularia nodosa (Linn.)—Frequent. *S. aquatica* not seen.
Digitalis purpurea (Linn.)—Isle Namanfin, &c., by no means common.
‡*Veronica buxbaumii* (Ten.)—Near Crum Castle. Probably occurs in many places.
V. arvensis (Linn.)—On the old walls, Devenish, &c. Common.
V. serpyllifolia (Linn.)—Common.
V. officinalis (Linn.)—Common.
V. chamædrys (Linn.)—Common.
V. montana (Linn.)—Frequent in shady places, and on Devenish, &c.
V. scutellata (Linn.)—Shores of Devenish, &c.
V. beccabunga (Linn.)—Common.

Veronica hederifolia (Linn.)—In the garden at Crum Castle. *V. agrestis*, *V. polita* and *V. anagallis*, ought also to occur. *V. agrestis* is in Mr. Stewart's list.

Euphrasia officinalis (Linn.)—Frequent.

Bartsia odontites (Huds.)—Not uncommon in some places.

Pedicularis palustris (Linn.)—Devenish, &c. Common.

P. sylvatica (Linn.)—White Island, &c. Frequent.

Rhinanthus crista-galli (Linn.)—Common everywhere.

Melampyrum pratense (Linn.)—Plentiful in many places. Gaffer Island, &c.

LABIATÆ.

Lycopus europæus (Linn.)—Boggy, cultivated ground, one mile west of Crum Castle.

Mentha hirsuta (Linn.)—Common.

M. arvensis (Linn.)?—Common on the shores of the islands in the lower lake.

Thymus serpyllum (Fries.)—Apparently not common.

Nepeta glechoma (Benth.)—Devenish, &c. Common.

**Melissa officinalis* (Linn.)—Occurs near the garden on the Island of Trasna, with *Tanacetum vulgare* and *Chrysanthemum parthenium*. All three probably planted.

Prunella vulgaris (Linn.)—Common everywhere.

Scutellaria galericulata (Linn.)—Only seen in the wood between Crum Castle and the farm-yard, where it is common in one spot.

Stachys palustris (Linn.)—Common.

S. sylvatica (Linn.)—Devenish, &c. Frequent.

Galeopsis tetrahit (Linn.)—In many places round both upper and lower lake, but not common.

Lamium purpureum (Linn.)—Common.

Ajuga reptans (Linn.)—Devenish, &c. Common everywhere.

[*Teucrium scorodonia* (Linn.)—Apparently wanting. Mr. Stewart does not mention it, and I have no entry of its occurrence.]

BORAGINACEÆ.

Myosotis cæspitosa (Schultz).—Common.

M. palustris (With.)—Common; perhaps more so than the last.

M. arvensis (Hoffm.)—Not very common.

M. versicolor (Reich.)—Common; met with more frequently than *M. arvensis*.

**Symphytum officinale* (Linn.)—I have this entered in my list as occurring near houses, but do not remember the locality.

PINGUICULACEÆ.

Pinguicula vulgaris (Linn.)—On Devenish; but rather a rare species about the lake.

PRIMULACEÆ.

Primula vulgaris (Huds.)—Devenish, &c. Common.
P. officinalis (Linn.)—Decidedly rare; but I gathered it in the lawn at Bellisle House, on the upper lake, and in one place near the lower lake.
Lysimachia vulgaris (Linn.)—Very common everywhere.
L. nemorum (Linn.)—Common.
Anagallis arvensis (Linn.)—In fields. Not common.
A. tenella (Linn.)—Very common.
Centunculus minimus (Linn.)—Rare. Only seen at Gubbaroe Point, near Kesh, in a sandy field.
Samolus valerandi (Linn.)—Common, and generally distributed.

PLANTAGINACEÆ.

Plantago major (Linn.)—Devenish, &c. Common.
P. lanceolata (Linn.)—Common.
Littorella lacustris (Linn.)—Margin of lake. Devenish Island, &c. Common.

CHENOPODIACEÆ.

Chenopodium album (Linn.)—Cultivated fields. Common.
Atriplex angustifolia (Sm.)—With the last species; but more plentiful, I think.

POLYGONACEÆ.

Rumex nemorosus (Schrad.)—Perhaps the commonest species, only var. *viridis*.
R. obtusifolius (Auct.)—Common. Devenish, &c.
R. crispus (Linn.)—Common.
[*R. conglomeratus* (Murr.)—This species may have been overlooked. In the "Cybele Hibernica" it is stated, that in Ireland *R. conglomeratus* is more abundant than *R. nemorosus*. I would say, not without diffidence, that *R. conglomeratus* is the more uncommon species of the two.]
R. acetosa (Linn.)—Common generally.
R. acetosella (Linn.)—Not seen immediately near the shore of the lower lake, but occurs on the hill over it at Pollaphuca, at about 800 feet.
Polygonum convolvulus (Linn.)—Rather rare near the lake.
P. aviculare (Linn.)—Not common; but seen near Crum Castle, and also near the lower lake.
P. hydropiper (Linn.)—Common.
P. minus (Huds.)—Very rare. Only seen sparingly at Gubbaroe Point, Kesh, on the shore.

Polygonum persicaria (Linn.)—Common.

P. amphibium (Linn.)—Plentiful in many places. All varieties occur between the form floating in deep water and that growing on dry banks next the shore.

**P. bistorta* (Linn.)—In a damp meadow, near the avenue at Ely Lodge; probably escaped from some garden.

[*P. lapathifolium* (Linn.)—On comparing a specimen considered to be this species with others in the British Museum, it proves to be only a luxuriant form of *P. persicaria;* but the true plant is likely to occur in boggy, cultivated fields near the lake.]

EUPHORBIACEÆ.

Euphorbia helioscopia (Linn.)—In fields at the east side of the lower lake, &c.

URTICACEÆ.

Urtica dioica (Linn.)—Common.

U. urens (Linn.)—At Belturbet, and probably in waste ground elsewhere.

**Ulmus suberosa* (Ehrh.)—At Ely Lodge, and Crum Castle, &c. Planted.

AMENTIFERÆ.

Quercus robur (Linn.)—Planted in many places, and native in other localities.

**Fagus sylvatica* (Linn.)—Planted about Ely Lodge, &c.

Corylus avellana (Linn.)—Common.

Alnus glutinosa (Linn.)—Common, generally.

Betula alba (Linn.)—Ely Lodge, &c. Frequent.

Myrica gale (Linn.)—Common.

**Populus tremula* (Linn.)—Shores of lower lake.

**Salix viminalis* (Linn)—Roadside from Pollaphuca to Blaney Bay. Perhaps planted.

S. cinerea (Linn.)—White Island, &c. Frequent.

S. aurita (Linn.)—Owl Island, &c.

S. caprea (Linn.)—White Island, &c.

S. repens (Linn.)—Owl Island.

CONIFERÆ.

**Pinus sylvestris* (Linn.)—Planted in many places.

TYPHACEÆ.

Typha latifolia (Linn.)—Rare. Only seen in a ditch near Castle Hume.

Sparganium ramosum (Huds.)—Near Blaney Bay, &c. Common.

Sparganium simplex (Huds.)—About three miles north of Enniskillen, on the east side of the lake, at the first inlet which comes close to the road.

S. minimum (Fries.)—In the same locality.

S. affine (Schn.) ?—Growing near *S. minimum*.

Of *S. affine* and *S. simplex* I have specimens, but I refer my specimen to the former species with some doubt, the fruit being imperfect.

ARACEÆ.

Arum maculatum (Linn.)—Not common. Near the lower lake.

LEMNACEÆ.

Lemna trisulca (Linn.)—In a ditch near Crum Castle.

L. gibba (Linn.)—In the lake, three miles north of Enniskillen, at the east side.

L. minor (Linn.)—Frequent.

NAIDACEÆ.

Potamogeton natans (Linn.)—Common. Devenish, &c.

P. polygonifolius (Pourr.)—Boggy drains north of Bla y ay, and elsewhere. Frequent.

P. heterophyllus (Schreb.)—Found floating by the shore of the lower lake in many places. Specimens identical with this compact and perhaps brittle form are in the British Museum Herbarium, from Lough Bofin, Co. Leitrim, collected by Mr. W. T. Thiselton Dyer.

P. lucens (Linn.)—Abundant in the upper and lower lake. A flowerless form, perhaps *acuminatus*, but with the prominent midrib not quite so marked as in the Cambridge specimens, was gathered. No specimen of this variety, either in the British Museum or at Cambridge, is in flower or fruit, and it may be but a young and immature state of *P. lucens*.

P. zizii (Roth.)—Plentiful in the lower lake near the entrance to the Kesh river, August, 1881. My specimens were submitted to Professor Babington. This species has a great look of *P. lucens*, but I saw no specimen with leaves of an intermediate shape either at the British Museum or Cambridge.

P. perfoliatus (Linn.)—Common.

P. filiformis (Nolte.)—In water, about three feet deep, between Kinnausy Island and the mainland, near Kesh. Plentiful just in the one spot.

ALISMACEÆ.

Triglochin palustre (Linn.)—Common about the lake.

Alisma plantago (Linn.)—Common. Devenish, &c.

A. ranunculoides (Linn.)—Shore of Devenish, and in one or two other places. Sparingly, and not common.

Hydrocharidaceæ.

Elodea canadensis (Rich.)—Drain on the Island of Trasna, and in other places. Not plentiful now. I was informed that a few years ago this plant, which the natives call "eel-weed," threatened almost to fill up Lough Erne. When introduced it spread with great rapidity round the islands and shores. It has since decreased equally fast.

[*Stratiotes aloides* (Linn.)—This species was not seen in Lower Lough Erne, nor in that portion of the upper lake I examined. The *immediate* neighbourhood of Crum Castle was visited, but the district between Crum Castle and Belturbet, where it is reported to grow plentifully, was not gone over.]

Orchidaceæ.

Orchis mascula (Linn.)—On White Island. Not common.

O. incarnata (Linn.)—Common. Devenish, &c.

O. maculata (Linn.)—Common generally.

Gymnadenia conopsea (Brown).—Rare. Only seen by the roadside, near Ely Lodge, when going to Enniskillen from Belleek.

G. albida (Rich.)—Rare. On the slopes of the hill over the lower lake at Pollaphuca.

Habenaria viridis (Brown).—In the same locality as the last species.

H. bifolia (Bab.)—On White Island, and fields near Blaney Bay. Not nearly so common as *H. chlorantha.*

H. chlorantha (Bab.)—This species and the next are the commonest orchids about Lough Erne.

Listera ovata (Brown).—Abundant.

Neottia nidus-avis (Rich.)—Under the old beeches opposite Crum Castle. Sparingly.

Epipactis latifolia (Auct.)—Common, especially under beech trees. I cannot distinguish between this species and *E. media.*

Iridaceæ.

Iris pseudacorus (Linn.)—Very common generally.

Liliaceæ.

Scilla nutans (Sm.)—Common. In great quantity in some places.

Allium ursinum (Linn.)—Common.

Narthecium ossifragum (Huds.)—On the hill over the lake at Pollaphuca; not seen at a lower level.

Juncaceæ.

Luzula pilosa (Willd.)—Rather common.

L. sylvatica (Beck.)—Abundant in many places.

Luzula multiflora (Koch.)—Common.

L. campestris (D. C.)?—This species was marked off in my list, perhaps hastily, for I do not feel sure that I met the typical form which, when compared with the frequency of *L. multiflora*, appears to be rare in Ireland.

Juncus conglomeratus (Linn.)—On Devenish, &c. Frequent.

J. effusus (Linn.)—Common.

J. glaucus (Sibth.)—Common generally.

J. acutiflorus (Ehrh.)—Very common.

J. lamprocarpus (Ehrh.)—Not uncommon.

J. supinus (Moench.)—Common.

J. bufonius (Linn.)—Both varieties common, i. e. *genuinus* (Syme) and *fasciculatus* (Koch.).

J. squarrosus (Linn.)—On the hill over the lower lake at Pollaphuca.

Cyperaceæ.

Schœnus nigricans (Linn.)—Frequent.

Scirpus acicularis (Linn.)—Rare. Shore of Devenish Island, and on east side of lower lake in one place.

S. palustris (Linn.)—Plentiful.

S. pauciflorus (Lightf.)—On the north end of Devenish Island. Rather rare elsewhere.

S. cæspitosus (Linn.)—On the hill over the lower lake at Pollaphuca. Not seen at a lower level.

S. setaceus (Linn.)—Springs on Devenish, &c. Frequent.

S. lacustris (Linn.)—Abundant everywhere round the lake.

Eriophorum vaginatum (Linn.)—On the hill over the lake at Pollaphuca.

E. angustifolium (Linn.)—Common.

Carex pulicaris (Linn.)—Common, and generally distributed.

C. disticha (Huds.)—Near Bellisle House, Upper Lough Erne. Common near the shore here.

C. paniculata (Linn.)—Rare. In a marsh between Crum Castle and the farmyard.

C. stellulata (Good.)—Common generally.

C. remota (Linn.)—On Devenish, &c. Frequent.

C. elongata (Linn.)—Very rare. Sparingly in a marsh between Crum Castle and the farmyard, with *C. paniculata*, *curta*, and others.

C. curta (Good)—Rare. Growing with the last-named species.

C. ovalis (Good)—Frequent. On Devenish, &c.

C. stricta (Good)—Along the margin of the lake. Common.

C. vulgaris (Fries.)—Very common.

C. glauca (Scop.)—Frequent.

C. præcox (Jacq.)—Not very common. Pasture near Castle Hume.

C. pallescens (Linn.)—Occurs in many places about the lake; often plentiful.

Carex panicea (Linn.)—Very common. A rather stunted form occurs occasionally, in which the spike is solitary, and apparently with very few or no male flowers.

C. sylvatica (Huds.)—Frequent.

C. lævigata (Sm.)—Rare. Only seen in a wood near the gamekeeper's lodge, on the west side of Lough Erne, at Crum Castle.

C. binervis (Sm.)—Rather uncommon about the lake.

C. hornschuchiana (Hoppe)—Devenish, &c. Common about the lower lake.

C. flava (Linn.)—Frequent.

C. œderi (Ehrh.)?—Young specimens, probably referable to this species, were gathered on the inundated shore of Devenish.

C. hirta (Linn.)—Common.

C. ampullacea (Good)—Frequent by the margin of the lake.

C. vesicaria (Linn.)—Shore of Devenish, &c. Not so common as *C. ampullacea.*

Gramineæ.

Anthoxanthum odoratum (Linn.)—Common.

Digraphis arundinacea (Trin.)—Common around the lake.

Alopecurus geniculatus (Linn.)—Frequent. Damp ditch on Devenish, &c.

A. pratensis (Linn.)—Frequent.

Phleum pratense (Linn.)—Not nearly so common as the last species, but may be found in many places: Ely Lodge, &c.

Sesleria cærulea (Scop.)—On the rocky face of Shean Hill at Pollaphuca, lower lake.

Agrostis alba (Linn.)—Frequent.

A. vulgaris (With.)—Frequent.

Phragmites communis (Trin.)—Abundant around the lake.

Aira cæspitosa (Linn.)—Occurs almost everywhere on the islands, &c.

A. flexuosa (Linn.)—Frequent in suitable places.

A. præcox (Linn.)—Not uncommon. Gubbaroe Point, Kesh, &c.

A. caryophyllea (Linn.)?—I have no entry of this species, but am pretty certain it was observed.

Avena flavescens (Linn.)—Dry pasture near Crum Castle.

Holcus lanatus (Linn.)—Common.

Molinia cærulea (Mœnch.)—Common.

Melica uniflora (Retz.)—Common in woods.

Catabrosa aquatica (Beauv.)—Frequent in boggy ground.

Glyceria fluitans (Brown)—Common.

G. plicata (Fries.)—Rare. In a ditch near Castle Hume, lower lake.

Poa annua (Linn.)—Common.

P. pratensis (Linn.)—Frequent.

Poa trivialis (Linn.)—Frequent.
Briza media (Linn.)—Occurs in most places; Devenish, &c.
Cynosurus cristatus (Linn.)—Common.
Dactylus glomerata (Linn.)—Common everywhere.
Festuca sciuroides (Roth.)—Sandy field at Gubbaroe Point, Kesh.
F. ovina (Linn.)—Not uncommon.
F. rubra (Linn.)—Common around the shore.
F. elatior (Linn.)—Frequent near the lake.
F. pratensis (Huds.)?—No specimen gathered, but probably occurs.
Bromus asper (Murr.)—Common in woods near shore.
B. mollis (Linn.)—Not uncommon. One specimen gathered comes near *B. racemosus*.
Triticum repens (Linn.)—Frequent.
Lolium perenne (Linn.)—Common generally.
L. italicum (Braun.)—Introduced in pasture, &c.
Nardus stricta (Linn.)—On the hill at Pollaphuca, &c.

FILICES.

Pteris aquilina (Linn.)—Occurs in many places.
Lomaria spicant (Desv.)—Frequent in suitable spots.
Asplenium ruta-muraria (Linn.)—Devenish, &c.
A. trichomanes (Linn.)—Not uncommon.
[*A. adiantum-nigrum* (Linn.)—I have no entry of this species, and do not remember seeing it. It is in Mr. Stewart's list.]
Athyrium filix-fœmina (Bernh.)—Common. On some of the islands the specimens are very large.
Scolopendrium vulgare (Sm.)—Devenish, &c. Not uncommon.
Polystichum angulare (Willd.)—Devenish, &c., but not very common.
Lastrea filix-mas (Rich.)—Frequent.
L. dilatata (Desv.)—Common.
L. æmula (Baker)—Rare. My specimens were gathered on the hill over the lake at Pollaphuca, in August, 1881. I could not find it in June, 1882.
Polypodium vulgare (Linn.)—Frequent.
Osmunda regalis (Linn.)—Rare. Only seen in one spot on Goat Island, lower lake.

LYCOPODIACEÆ.

Lycopodium selago (Linn.)—On the hill over the lake at Pollaphuca.

EQUISETACEÆ.

Equisetum arvense (Linn.)—Common.
E. maximum (Linn.)—In several places about the lower lake.
E. sylvaticum (Linn.)—Frequent, but not common.

Equisetum palustre (Linn.) — Frequent. Remarkably large fertile stems in some shady places, with spreading branches.

E. limosum (Linn.)—Plentiful round the shore in most places.

CHARACEÆ.

Chara fragilis (Desv.), var. *capillacea* (Thuil.)—By the lower lake, three miles north of Enniskillen. Var. *delicatula* was collected at Blaney Bay. Named by Mr. H. Groves.

Nitella opaca (Ag.)—Blaney Bay and Devenish Island.

NOTE ADDED IN PRESS

[October, 1883.]

The living specimens believed to be *Hieracium umbellatum* have flowered, and prove the species to have been correctly identified by my friend Mr. A. G. More, to whose well-known critical eye I have been so much indebted when naming doubtful species.

II.—RECENT ADDITIONS TO THE FUNGI OF COUNTIES DUBLIN AND WICKLOW. By GREENWOOD PIM, M.A., F.L.S.

[Read, May 28, 1883.]

In the early part of 1878, by request of the Committee appointed to prepare the Guide to County Dublin, in connexion with the British Association meeting of that year, I compiled a list[1] of the Fungi which had been recorded from County Dublin and County Wicklow, as it was thought desirable to include the latter in the fauna and flora of the district.

As I then pointed out, this catalogue was extremely imperfect, being little more than a transcript of my own notes made within a short time, and with almost no opportunity of check. A short list of less than a dozen species collected in Powerscourt, which I received from the Rev. M. J. Berkeley, was not included, but will be found appended to this Paper.

In very many instances, the species enumerated in my own list were identified merely from description, as Dr. Cooke's beautiful illustrations of the Helvellacei and Agaricini had not been published, and time did not permit my consulting other works than those in the National Library of Ireland, which are not of very recent date in many cases.

During the five years which have elapsed since the meeting of the British Association, some sixty additional species have come under my notice, although from various reasons I have been able to devote very little time to the study of Fungi. I am quite sure there are a large number still unrecorded.

Of these additions, I wish to draw the attention of the Academy to a few of the more remarkable forms, several of which are, so far as I have been able to ascertain, undescribed, at least in any work to which I have access.

Passing by some twelve or fourteen Agarics and allied species, I would note the occurrence of *Polyporus giganteus* last summer in Powerscourt. It was an enormous specimen, growing layer above layer in an imbricated manner, and forming a tuft nearly three feet in diameter, of a light buff, flecked with chestnut colour, and very pretty. It grew at the root of a large beech tree. In the same demesne near the Waterfall, I collected the Beefsteak Fungus, *Fistulina hepatica*, on an old oak.

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[1] Proceedings Royal Dublin Society, n. s., vol. i., p. 283.

Of Auriculariacei we have two species: one of them a Cyphella. Mr. Phillips believes it to be new to science.

Of Gasteromycetes four are added. Of Coniomycetes, nine; amongst the latter, a form of Chalara on the interior of a cocoa-nut perhaps distinct from that figured by Corda—viz., *C. fusidioides*. Also the curious forms *Echinobotryum atrum* and *Tetraploa aristata*, both very rare in England and on the Continent, and now recorded for the first time in Ireland.

To the Hyphomycetes, or moulds, fifteen species and varieties are added, of which I claim four as new. These are *Alliospora sapuçaya* (Pim); *Helminthosporium gymnostachyi* (Pim); *Stysanus stemonitis*, var. *ramosa* (Pim); and *Ramularia cryptostegiæ* (Pim). Full descriptions will be found in the appended lists. *Alliospora sapuçaya* is by far the most curious form, combining, as it does, the characteristics of three other genera, viz. Aspergillus, Haplaria, and Verticillium.

Tuber æstivum, the summer truffle, occurred abundantly at Farmleigh, Castleknock, where it was discovered by a French cook. It is used there for culinary purposes. I am not aware of its occurring elsewhere in Ireland, though most likely it and many other subterranean forms are overlooked through being buried.

In conclusion, I can only reiterate an oft-expressed desire that some others would take up this work, that we might have some knowledge of the Fungi of other parts of Ireland, and of such groups as the Sphæriacei, Tuberacei, Hypogæi, &c., which have so far been entirely neglected.

Agaricus (Lepiota) acutesquamosus (Wm.), in a stove, Monkstown.
,, ,, clypeolarius (Bull), Monkstown.
,, (Tricholoma) immundus (Bk.), Powerscourt.
,, ,, brevipes (Bull), Dargle.
,, (Clitocybe) ectypus (Fr.), Bray.
,, ,, dealbatus (P.), Powerscourt.
,, (Collybia) butyraceus (Bull).
,, (Clitopilus) prunulus, *var.* Orcella (Scop.), Powerscourt.
,, (Mycena) polygrammus (Bull), Glasnevin.
,, (Pholiota) aurivellus (Batsch), Trinity College Bot. Gard.
,, (Hebeloma) fastibilis (Fr.), Bray.

Gomphidius viscidus (Fr.), Bray.

Lactarius hysginus (Fr.), Ovoca.
,, subdulcis (Fr.), Dargle.

Boletus piperatus (Bull), Bray.

Polyporus perennis (Fr.), Dargle.
,, ribis (Fr.), Monkstown.
,, giganteus (Fr.), Powerscourt.

Hydnum niveum (P.), Trinity College Botanical Gardens.
,, plumosum (Duby), near Bray.

Thelephora cristata (Fr.), Dargle.

Cyphella, sp. nov., Monkstown.

Tremella foliacea (P.), Shankill.

Octaviania asterosperma (Vitt.), Monkstown.

Geaster michelianus (Sow.), Trinity College Bot. Gard.

Hemiarcyria clavata (P.), Monkstown.

Trichia varia (P), Glasnevin.

Septoria cannorum (n. s. Pim), Monkstown. Pale yellow spores; about five-septate; very slightly curved; on root of *Canna indica;* Monkstown, March, 1879.

Echinobotryum atrum (Ca.), cut timber, Monkstown.

Torula sporendonema (B. and Br.), on cheese.

Chalara cocos (Pim), doubtfully distinct from C. fusarioides (Corda).

Speira toruloides (Ca.), Monkstown.

Tetraploa aristata (B. and Br.), on Pampas grass, Monkstown.

Puccinia glechomatis (D. C.), Enniskerry.

„ scorodoniæ (Lk.), Dargle.

Ræstelia lacerata (Tul.), Ovoca.

Epicoccum neglectum (Desm.).

„ var. papaveris (Pim), on poppy, Monkstown.

Helminthosporium simplex (Kze.), on Gladiolus.

„ echinulatum (Bk.), on Eucalyptus.

„ gymnostachyi (Pim), irregular.—Blackish spores; very long sometimes; concatenate; sometimes with hyphæ at both ends; endochrome divided into oblong masses, as in H. Smithii; perhaps scarcely a good Helminthosporium; on Gymnostachyum.

Alliospora sapuçayæ, nov. gen. et spec.—A curious black mould, having minute spherical heads, borne on erect flocci. Head consists of a small globose columella, surrounded by a dense stratum of closely-packed basidial cells, from which depend slender hyphæ, clustered with spores, and branched verticellately at the top. On decaying sapuçaya nut, 1882.

Verticillium aspergillus, dead Polyporus, Monkstown.

Oidium chartarum (Lk.), damp wall paper (Mr. A. Balfe).

Stysanus stemonitis (Ca.), Monkstown.

„ var. ramosa (Pim), a well-marked branched form of the species.

Dactylium roseum (Bk.), Monkstown.

„ obovatum (Bk.), Monkstown.

Botryosporium diffusum (Ca.), decaying stems; abundant.

Ramularia cryptostegiæ (Pim), on seeds of Cryptostegia.

Tuber æstivum (Vitt.), Farmleigh.

Peziza tectoria, Glasnevin.
,, calyculaeformis (Schum.), near Bray.
,, trechispora (B. and Br.), Dunran Glen.

Xylaria carpophila (Fr.), Glendruid.

Epichloe typhina (B.), Ovoca, Dargle.

Sphæria aquila (Fr.), Monkstown.

Capnodium footii (B. and D.), Monkstown.

The following were found by Mr. Berkeley in Powerscourt :—

Agaricus (Lepiota) delicatus (Fr.); Agaricus calamistratus (Fr.); Agaricus scolecinus (Fr.); Polyporus hibernicus (B. and Br.); Nidularia pisiformis (Tul.); Merulius pallens (B.); Schinzia alni (Wor.). He also records Sphæria Keitii from Glasnevin.

III.—ON A PLANE REPRESENTATION OF CERTAIN DYNAMICAL PROBLEMS IN THE THEORY OF A RIGID BODY. By ROBERT S. BALL.

[Read, April 9, 1883.]

IN the following Paper I propose to exhibit a method of studying by merely plane construction the theory of certain problems in a rigid system which has two degrees of freedom. The problems referred to are those in which the rigid body remains always in the vicinity of its original position, so that the dynamical questions are merely those of equilibrium, of impulsive forces and of small oscillations.

We must refer to the "Theory of Screws" for an outline of the principles on which the present method is based. We there find that when a body has freedom of the second order it is always capable of twisting about every screw of a certain group which lie on the ruled cubic surface called the cylindroid. Each screw has a pitch appropriate to its situation on the cylindroid, so that while the body has two degrees of freedom, and is thus capable of attaining a position which can be defined by two generalized co-ordinates, one of these co-ordinates may be regarded as indicating the screw about which the body is twisted, while the other gives the amplitude of the twist. We may consider each screw of the system to be denoted by a point in a plane, or we may regard a group of points in a plane which correspond respectively with the group of screws on the cylindroid. As the screws on the cylindroid are only a singly infinite series, so the points in the plane must be only a single infinite series; in other words, they must lie upon a curve. As also when we proceed around the cylindroid we return to the screw from which we started, it would seem natural that the curve of points should be a closed curve. What is this closed curve to be? It will be easy to show that we can obtain many advantages by taking this curve to be a circle.

Let α and β be two screws on the cylindroid. We select first of all a point A quite arbitrarily which shall correspond to α. We may for the moment regard the choice of B, the point corresponding to β, as also arbitrary. Let θ be a third screw on the cylindroid, and let P be its corresponding point on the plane. There will be a great convenience in choosing P, so that the triangle ABP shall bear some quickly intelligible relation to the set of screws α, β, θ. We are here reminded of the fundamental property of the cylindroid that three twists on any three screws will neutralize, provided that each twist has an amplitude proportional to the sine of the angle, between the other two screws. It is therefore natural to choose P, so that the sides of the triangle ABP shall be respectively proportional to the amplitudes of the twists about the corresponding screws. Hence it follows that the angle which P subtends at A and B must be equal to the angle between the two screws A and B. Now as this

must be true for each screw on the cylindroid, it is obvious that the angle subtended by P must be constant, or, in other words, that the locus of P is a circle. We are thus led to study the correspondence of the screws on a cylindroid with the points on a circle.

We can exhibit this correspondence in a very direct manner by the formulæ given in "Screws," p. 15. The position of a screw is defined by the two equations

$$y = x \tan l,$$

$$z = (p_\alpha - p_\beta) \sin l \cos l;$$

while the pitch p of the screw is

$$p = p_\alpha \cos^2 l + p_\beta \sin^2 l.$$

In these equations p_α and p_β are the pitches of the two principal screws of the cylindroid which intersect at right angles in the origin, and l is the angle made by a variable screw with the axis of x. If we write

$$p_0 = \tfrac{1}{2}(p_\alpha + p_\beta); \quad m = \tfrac{1}{2}(p_\alpha - p_\beta);$$

and if we eliminate l from the two last equations, we obtain the result

$$(p - p_0)^2 + z^2 = m^2:$$

regarding p and z as current co-ordinates, this equation denotes the circle which corresponds point to screw with the screws on the cylindroid. It will, I think, be found that the correspondence presents the various problems which arise with a degree of elegance hardly to be anticipated from the mode in which the circle has been determined.

Describe the circle HPQ, with H as centre and m as radius, and the plane representation of the cylindroid is complete.

Draw an arbitrary straight line LM (Fig. 1), and a perpendicular, HN, to this line; the distance NH is equal to p_0, which is the constant part in the expression of the pitch of a screw on the cylindroid, the expression of any pitch being

$$p_0 + m \cos_2 l.$$

Take a point P, corresponding to any screw on the cylindroid, and let fall PA perpendicular on LM; then PA is the pitch of the screw corresponding to P. If Q be a second point on the circle, then QB is the pitch corresponding to Q, while the intercept AB between the two perpendiculars is the shortest distance between the two corresponding screws. The angle subtended by the arc PQ, at any point of the circumference, is the angle between the two screws. It will now be easily seen how the screws determine the circle just as they determine the cylindroid. Draw a pair of parallels whose perpendicular distance AB is equal to the shortest perpendicular distance

of the two screws. From A and B set off distances AP and BQ equal to the pitches of the two screws, and having thus found P and Q, describe a circle through those points, so that the angle subtended by PQ at the circumference shall equal the angle between the two screws. It thus appears that P and Q in this method cannot be chosen arbitrarily, for PQ^2 must equal the square of the shortest perpendicular distance between the two screws, plus the square of the difference between their pitches.

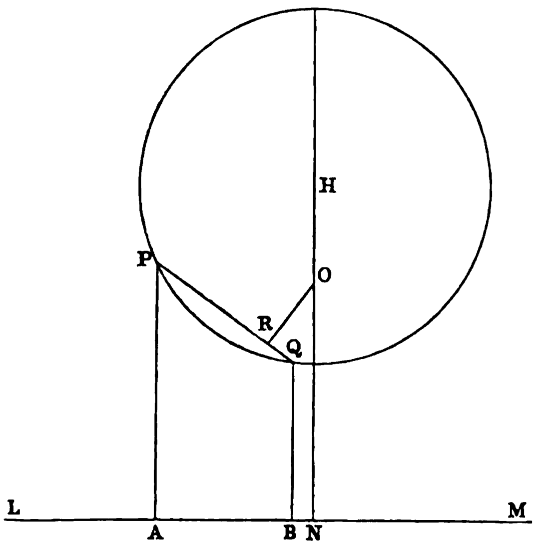

Fig. 1.

It is now extremely easy to identify the various points on the circle with their corresponding screws on the cylindroid. Any parallel to LM will cut the circle in two points corresponding to two screws of equal pitch; any perpendicular to LM will cut the circle in points corresponding to intersecting screws; a perpendicular to LM through H, the centre, cuts the circle in points corresponding to the two principal screws of the cylindroid; a parallel to LM, through H, cuts the circle in the points which correspond with the terminal screws of the cylindroid, and the points in which LM cuts the circle give the screws of zero pitch: the extremities of any diameter of the circle correspond with a pair of screws at right angles; and if a third screw Z be introduced, then the twists or wrenches about P, Q, Z, which would neutralize, are respectively proportional to the sides of the triangle PQZ.

The interpretation of reciprocal screws on the cylindroid is some-

what remarkable when viewed in the present method. Let O be the pole of the pitch-line LM, with regard to the circle; then the theorem to be proved is that any chord through O intersects the circle in a pair of points which correspond with a pair of reciprocal screws on the cylindroid. It will be nearly as easy to prove this in a more general form, viz., that the virtual coefficient of any two screws is proportional to the perpendicular OR, let fall from O on the chord PQ, joining the two corresponding points.

From the figure, it is very easily seen that

$$OR = m \cos(l - l') - OH \cos(l + l');$$

whence

$$\frac{p_0}{m} OR = p \quad \cos l \cos l' + p_\beta \cos m \cos m';$$

but the right-hand member is the virtual coefficient of the two screws ("Screws," p. 37), and hence the required theorem has been proved.

It is now easy to find the screw on a cylindroid reciprocal to a given screw; for, join the point corresponding with the given screw to the pole of the pitch-line, and the point where the chord cuts the circle again is the correspondent of the required screw. If the screws have a given virtual coefficient, then the chord joining them envelops a circle whose centre is the pole of the pitch-line.

The graphical method of this Paper is also very convenient for the illustration of the dynamical questions of impulsive forces and of small oscillations. If a rigid body with two degrees of freedom be at rest, and if it receive an impulsive wrench on any arbitrary screw, then it is well known that without any sacrifice of generality we may replace the given impulsive wrench by a wrench on a screw of the cylindroid expressing the freedom ("Screws," p. 59). We thus have two corresponding systems of screws on the cylindroid, and the correspondence being strictly of the one-to-one type is homographic ("Screws," p. 106). We thus have in the present way of looking at the subject two sets of homographic point-systems on the circle. We shall call P_1, P_2, &c., the impulsive screws, and Q_1, Q_2, &c., the corresponding instantaneous screws. The general theory of such point-systems on a circle is, of course, well known, and it may be of interest to trace how in the present case the homography departs from the general type.

If we join P_1, Q_2, and also P_2, Q_1, the joining lines intersect on a point collinear with the similar intersections obtained by taking every other two pairs of impulsive and instantaneous screws. The axis thus obtained intersects the circle in the two double points of the homography. The screws corresponding to these points are what we have called the principal screws of inertia. They are, in fact, the screws, a wrench on either of which will force the body to commence its movement by twisting around the same screw. Now, although this axis may remain arbitrary in the case of a perfectly general homography, yet, in the special kind of homography now before us, this axis must

fulfil one special condition—it must always pass through O, the pole of the line by which the pitches are determined. This is easily shown, for we have proved ("Screws," p. 48), that if P_1 and Q_2 be reciprocal, then P_2 and Q_1 must also be reciprocal. Now P_1 may be chosen arbitrarily, and so can Q_2, and, if reciprocal, the chord must pass through O; therefore P_2, Q_1 must pass through O, or O must be a point on the axis of homography. The fact that the axis must pass through O involves as a consequence the theorem otherwise well known, that the principal screws of inertia on the cylindroid are reciprocal. It is thus interesting to note how the dynamical conception of conjugate screws of inertia is illustrated by an elegant geometrical theory.

We can still further simplify the subject geometrically by the property of the conjugate screws of inertia. Let A and B be two fixed points on a circle, and P and Q be two variable points; then if α and β be both constants, and if the condition

$$\alpha \sin PBA \,.\, \sin QBA + \beta \sin PAB \,.\, \sin QAB = O$$

be fulfilled, then it is easy to show that the chord PQ must pass through a fixed point; but the condition that P and Q shall correspond with a pair of conjugate screws is of this type ("Screws," p. 48), and hence we have the interesting result that all the chords joining a pair of conjugate screws of inertia, P and Q, must intersect in the same point O'.

By the help of this theorem we are now enabled to construct the pairs of impulsive and instantaneous screws with the greatest facility.

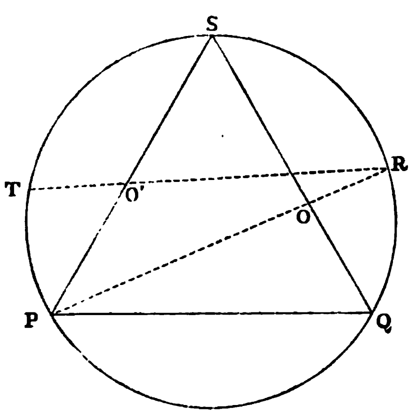

Fig. 2.

Let P (Fig. 2) be an instantaneous screw; then if we draw the chord PO' it will intersect the circle again at S; and then the chord SO

must cut the circle in Q, which corresponds with the required impulsive screw. We may state the matter also in a somewhat different manner. Let S be the vertex of a variable triangle inscribed in the circle whose two sides SP and SQ pass through two fixed points, O and O', then the extremities of the base of this triangle trace out the required homographic systems. One extremity corresponds to the given instantaneous screw; the other is the impulsive screw. The relation is not usually an interchangeable one. If Q be the impulsive screw corresponding to P as an instantaneous screw, then to find the instantaneous screw corresponding to P as an impulsive screw, we must draw PO and RO', thus determining T, which corresponds to the required instantaneous screw. The line OO' of course intersects the circle in points which correspond to the principal screws of inertia.

It is, however, to be noticed, that if in one case the relation of the screws as instantaneous and impulsive be interchangeable, then it must be interchangeable in every case. In these circumstances, any chord through the pole of the homographic axis intersects the circle in a pair of points so related.

A somewhat paradoxical case may be glanced at. The polar of O' cuts the circle in two points, and if either of these points be regarded as corresponding to an instantaneous screw, then the impulsive wrench will, from the foregoing construction, lie on a reciprocal screw; but from the nature of the reciprocal screws it would seem impossible that an impulsive screw and an instantaneous screw could be so related. The paradox is explained by the fact that the instantaneous screw is here imaginary, and possesses the curious property, that even with an unit of twist velocity the kinetic energy is zero. Under these circumstances, the only way of preventing a finite impulsive wrench from generating an infinite twist velocity is to have the screws reciprocal.

As the pitch of a screw can be expressed in the form $p_1 a_1^2 + p_2 a_2^2$, and as the kinetic energy for unit twist velocity has the form $u_1^2 a_1^2 + u_2^2 a_2^2$, it follows that the law which exhibits the pitch distribution must have a parallel in the law which shows the distribution of kinetic energy. We thus have the result, that a perpendicular from any point of the circle on the polar of O' is proportional to the kinetic energy due to a unit twist velocity about the corresponding screw.

In the case of small oscillations with forces having a potential, we find a third point, O'', any chord through which intersects the circle in points conjugate with regard to the potential. The chord $O'O''$ intersects the circle in the two points corresponding with the two harmonic screws.

ADDENDUM [5*th June*, 1883.]

[Read, 25th June, 1883.]

I HAVE for some time been seeking to obtain a clear geometrical conception of the intensity of the impulsive wrench which is capable of giving the unit of twist velocity on the instantaneous screw. I desired to connect this with the geometrical illustration which forms the basis of the present Paper. It was only within the last few days that I noticed the solution of the problem, which it is the object of this note to communicate.

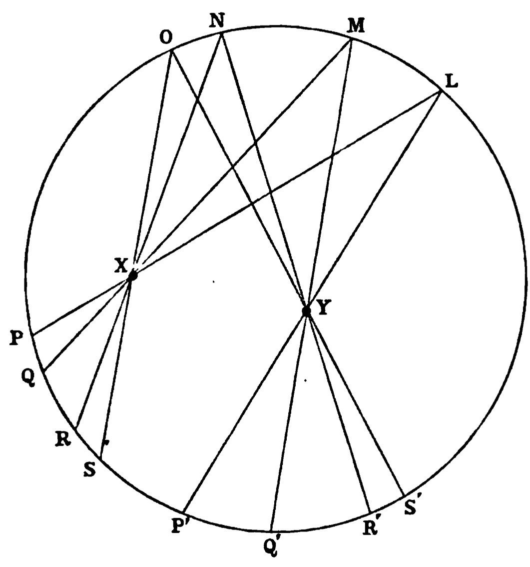

Fig. 3.

Let P, Q, R, S be points on the circle corresponding to four impulsive screws, and let P', Q', R', S' be the four corresponding instantaneous screws deduced by the construction already given. Let p, q, r, s denote the intensities of the impulsive wrenches on P, Q, R, S, which will give the units of twist velocity on P', Q', R', S'. Supposing that impulsive wrenches on P, Q, R neutralize, then the corresponding twist velocities generated on P', Q', R' must neutralize also. In the former case, the intensities must be proportional to the sides of

the triangle PQR; in the latter, the twist velocities must be proportional to the sides of the triangle $P'Q'R'$. If, therefore, d be a constant, we have

$$rP'Q' = dPQ,$$

$$qP'R' = dPR,$$

$$pQ'R' = dQR.$$

We have similarly the three other groups of equations

$$rQ'S' = aQS, \qquad qP'S' = cPS, \qquad rP'S' = bPS,$$

$$qR'S' = aRS, \qquad pQ'S' = cQS, \qquad pR'S' = bRS,$$

$$sR'Q' = aRQ. \qquad sQ'P' = cQP. \qquad sR'P' = bRP.$$

Whence we easily deduce

$$ap = bq = cr = ds = hpqrs;$$

whence H is a new constant. We hence obtain from the first equation

$$P'Q' = hPQpq.$$

As this is absolutely independent of R and S, it follows that h must be independent of the special points chosen, and that consequently for *any* two points on the circle P and Q, with their corresponding points P' and Q', we must have

$$pq \propto \frac{P'Q'}{PQ}.$$

In the limit we allow P and Q to coalesce, in which case, of course, P' and Q' coalesce, and p and q become coincident; but obviously we have then

$$PQ : ML :: PX : LX,$$

$$P'Q' : ML :: P'Y : LY;$$

whence

$$\frac{P'Q'}{PQ} = \frac{P'Y}{PX} = \frac{LX}{LY};$$

and as

$$P'Y \propto \frac{1}{LY} \quad \text{and} \quad PX \propto \frac{1}{LX}$$

we have finally

$$p \propto \frac{LX}{LY}.$$

The result is, therefore, one of very great simplicity, and the geometrical solution of the problem is now quite complete. Being given the impulsive screw corresponding to P, we find P' by drawing PXL and LYP': then to produce an unit twist velocity on P', the intensity of the impulsive wrench must be proportional to $LX \div LY$. More simply still, by a proper choice of units, LX will be the intensity of the impulsive wrench, and LY the acquired twist velocity.

It can also be shown that the chord joining A and P' is divided by the homographic axis at Z, so that the ratio of PZ to PX' varies proportionally with the square of the twist velocity about P' produced by the unit of impulse on P.

The line PP' envelops a conic, and the point of contact divides PP' into two segments, whose ratio is proportional to the square of the twist velocity acquired by an impulsive wrench of unit intensity.

IV.—Consideration of the Structural and Acquisitional Elements in Dextral Pre-eminence, with Conclusions as to the Ambidexterity of Primeval Man. By George Sigerson, M. D., Ch. M.

[Read, June 25, 1883.]

The subject of the preferential employment of the right hand, with incidental reference to dextral predominance generally, is one which has attracted some attention and given rise to different opinions. It is a question obviously surrounded by difficulties, and therefore that there have been conflicting speculations is not a matter of surprise. If I venture to deal with it now, it is because a certain number of facts have come under my observation which, by permitting the adoption of a method of exploration that is new as regards this subject, though it has rendered good service in others, are calculated to secure some addition to the domain of exact knowledge.

I. From the most ancient times, of which record remains to us, it would appear that special attention was given to the right—at least, in certain races. *The Book of the Law of Menu*, which has been referred to the thirteenth century[1] before the Christian era, is precise upon this point. The distinction is not made on account of the creation of mortals being assigned to either lateral portion of the Self-Existent Being. Still, in the religious ceremonies, the worshipper should walk around the sacred fire from left to right, and use the right hand in pouring the water.[2] Again, when passing by, a Brahman should always keep his right to a mound of earth, a cow, an idol, a Brahman, a vase of clarified butter or of honey, a place where four roads meet, and well-known great trees.[3] In the Bible there are several passages indicating that the right was associated with exceptional honour: the most prominent, though not the most ancient, being found in the Psalm commencing, "Dixit Dominus Domino meo: sede a dextris meis."[4] Evidence exists, and has already been noted, that amongst the Greeks and Romans (as amongst the French), the left was associated with awkwardness and untowardness. Dr. Hollis has remarked that on most ancient stone monuments and rock sculptures at Gizeh, Angkor, and Mundore, as well as in the Assyrian bas-reliefs, the right hand subserves the purposes of supplication or war.[5] An

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[1] M. Chézy, *Journal des Savants*, 1831, cited and endorsed by M. Loiseleur Deslongchamps.

[2] B. iii. 214. V. q. Sir Samuel Ferguson's article on the ancient Irish Ceremonial of Deisiul.—*Proc. R.I.A.*

[3] B. iv. 39.

[4] V. q. Gen. xlviii. 14–19; Judges iii. 15, 21.

[5] *Journal of Anatomy and Physiology*, vol. ix., p. 263.

examination of the casts contained in our National Gallery shows that, in peace, the left hand carries, whilst the right is extended; in war scenes, the left grasps the bow, whilst the right draws the cord.

If a law existed so absolute and universal as would appear from these indications, it would be almost impossible to resist the idea that it was the inevitable expression of structural peculiarities, and that nothing more remained to be said. But this is not the case. In the same Sanskrit work to which I have referred, it is shown that ablution might be made with the pure part of the hand, consecrated to the Veda (at the root of the thumb), or to the Creator (at the root of the little finger), or to the gods (the tips of the fingers); but never with that part named from the Pitris, or Manes, which is between the thumb and the index.[6] Hence there were auspicious and inauspicious parts in the same hand. Again, a Dwidja, or Regenerate, invested with the sacred cord, receives one name, Upavîtî, when his right hand is raised (and the sacred cord or his garment is attached to the left shoulder, and passes under the right); he is given another appellation, Prâtchînâvîtî, when his left hand is raised (and the cord, fixed on the right shoulder, passes under the left); he obtains a third, Nivîtî, when the cord is attached to his neck.[7] These are evidently grades of honour, and here the left seems dignified above the right. The Greeks, again, had two words for left—one, σκαιος, radically evil-meaning; but the other, ἀριστερὸς, appears to have a not unfavourable origin, since ἀριστεία meant valour. Sinister, in Latin, has bequeathed its bad repute, yet it was sometimes used in an auspicious sense: "*Liquido exeo foras, Auspicio, avi sinistrâ.*[8] But *lævus* appears with better associations (*lævo,* I polish, smoothen), and not unfrequently signifies favourable, *e. g.*: "*Si quem Numina læva sinunt auditque vocatus Apollo*" (Virgil). It has been stated that this auspicious signification arose from the fact that in augury the augurs stood facing the south, and the left, being towards the rising sun, was consequently favourable. But this does not lessen the value of the fact. In the ancient Irish—which peculiarly deserves citation since it escaped the Latin influence—the word ꝺeaꞅ, signifying the right, means also the south, and beautiful; behind and west are synonyms; ꞇuaꞃ means the north, and ꞇuaċ the left; whilst ciaꞇan and cioꞇoꝟ mean the left hand, but not the north. Cioꞇaċ, left-handed, is sometimes interpreted as awkward. But, again, ciaꞇaċ signifies graceful, and the designation of a distinguished chief, "Coll-kitto,"[9] was no imputation of awkwardness. A left-handed blow

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[6] B. ii. 58, 59. [7] B. ii. 63. [8] Plaut. *Epid.* ii. 2, 1.

[9] Cf. Cassius Scæva, Mucius Scævola. The Rev. Dr. Haughton has called my attention to the left-handed slingers of the tribe of Benjamin. In Judges xx. 15, 16, some statistics are given, for it stated that of the 26,700 Benjamite swordsmen, there were 700 chosen men left-handed, every one of whom could sling stones at a hair and not miss. Again, Judges iii. 15, *et seq.*, Elud, the Ben-

has an established reputation for effectiveness. Again, in the statue of the Strigil-bearer, the left hand is shown in action.

Finally, Dr. Erlenmeyer, whilst noting that most of the Aryans write from left to right, and that most of the Semitic peoples write from right to left, maintains that the writers of the Old Testament, and probably the early Talmudists, so wrote because they used their left hands. To write with the other was a difficulty; and he points out that it is on this account that the Talmud orders that certain special prayers are to be written with the right hand. This argument is certainly as valid as the converse contention which, remarking the existence of a specific term for left-handedness in a language, would infer the right-handedness of the race which used that speech. Dr. Erlenmeyer quotes passages from the text of the Old Testament emphasising, as he considers, the left-handedness of the Hebrew race. The argument for the existence of a left-handed people is, moreover, confirmed by the record of actual observation, inasmuch as in the account of Vasco di Gama's voyage to Calicut it is stated that the inhabitants of Melinda—"a polished and flourishing people"—were all left-handed.[10] From what precedes, we may, I think, legitimately conclude that it is, at least, highly improbable that the preferential use of the right hand, now prevalent, depends upon the imperative dictates of the anatomical structure of the human organism. Under that theory, left-handedness would be a "monstrosity," and come within the domain of teratology, which seems to have been the view of Dr. Ogle, who stated that it resembled many physical malformations in being hereditary, and attaching rather to the male than to the female sex.[11] This remark can scarcely be entitled an argument, for heredity is no special appanage of malformations, and whatever latent transmitted tendency may exist will be more developed in the members of that sex to which it is more taught, or which more requires it. Hence, if not bound by an absolute rule of structure, we are free to regard left-handedness, when it does occur, as a reversion to an earlier normal type, if it should so please us; or to derive it, with right-handedness, from a common ambidextrous ancestry, as I maintain.

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jamite, a Deliverer, is noted as left-handed. He girded his dagger on his right thigh. As his peculiarity put Eglon, King of Moab, off his guard, it may be inferred that the Moabites were right-handed, in this particular. Professor W. M. Hennessy finds, in the ancient Irish tract of the Battle of Ross-na-Righ, a champion represented as doing fearful havoc on foes by a "left-handed mill-grind" with his sword. In the Indian collection, Belgaum, South Kensington Museum, are shown two women grinding at a mill—a quern; the woman who turns the upper stone, by means of a short upright staff, grasps this staff in her left hand.

[10] Horne Tooke: *Diversions of Purley*, 1805, vol. ii. 10. The existence of left-handed tribes in India is recorded. [For a summary of Dr. Erlenmeyer's observations, see *British Medical Journal*, June, 1883.]

[11] *Proceedings* of Royal Medical and Chirurgical Society, London—*Lancet*, July 8, 1871.

II. The arguments from structure require particular attention. In 1810 it was first laid down, so far as I have ascertained, that the preferential use of the right hand is due to a natural peculiarity in the form of the right subclavian and carotid arteries, and that a similar preference is traceable in some dogs and horses as regards the fore extremity.[12] This statement was omitted from subsequent editions of the *Encyclopædia*. In 1871 Dr. Ogle gave a development of this theory. Maintaining that the left hemisphere of the brain is pre-eminently more complex in right-handed people; and conversely, that the right hemisphere predominates in left-handed persons, he argued that the cause of the greater development, as a rule, of the left hemisphere probably depends on its receiving a freer supply of blood than the right. He observes that the left arteries of the neck are, as a rule, slightly larger than the right, and that (independently of the size of the vessels) the stream of blood is less hindered on the left side than on the right. Man, he added, is not the only animal with a tendency to use one side preferentially, as monkeys and parrots also exhibit it. This structural explanation Dr. Ogle regarded as corroborated by the peculiarities of the cerebral blood supply in such animals.[13]

Now, the anastomoses of the vertebrals and carotids at the base of the brain must mitigate, if not eliminate, any lateral inequality; but that inequality, if it exist, has appeared to some anatomists to favour the right side, not the left. Thus, Mr. Erasmus Wilson, describing the common carotids, says—"It follows, therefore, that the right carotid is shorter than the left; it is also more anterior, and, in consequence of proceeding from a branch instead of from the main trunk, it is larger than its fellow." Under such circumstances, the right hemisphere should have the better blood supply. It is to be remarked that no notice is taken of the compensatory action of the vertebrals, any more than of the interposition of the Circle of Willis.

The second branch of the argument deserves peculiar attention. It is asserted that the preferential use of the right extremity depends upon the mode of origin of the brachial and cephalic arteries. In man (usually) there is a right brachio-cephalic trunk which bifurcates into the right common carotid and right brachial, or sub-clavian; on the left, the common carotid comes off direct from the arch of the aorta, so likewise does the left brachial. Now, if we admit that, on account of this arrangement, the left side of the head receives a freer and fuller supply of blood than the right side, we must logically go further, and assert that not only does the right side of the head receive a less free and full supply of blood than the left, but also (be it noted) we must maintain that a freer and fuller supply of blood goes to the

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[12] *Encyclopædia Britannica*, 1810: Art.—Comparative Anatomy—cited by Mr. Pearson, of Emmanuel College—*Lancet*, November 27, 1875.

[13] *Lancet*, July 8, 1871.

left arm than what proceeds to the right. If, therefore, the size and activity of an organ depend, as asserted with respect to the hemispheres, on its blood supply, it would follow from the structure-argument that in right-handed people the left hand is, *per se*, the stronger and more active!

It might possibly, but improbably, be argued that the influence of the left hemisphere counteracts this left lateral strength. But if the hemispheres are removed dogs can yet walk, and birds fly, and frogs swim, on being stirred by external stimulus, whence it is inferred that, though the seat of the volition be in the hemispheres, these do not impart the power of motion. The cerebrum being concerned with volition, a greater size and complexity of one of its hemispheres may certainly indicate greater volitional activity there; but we should look further down, to the brachial centres, in order to discover if there be inequality here discernible. That these are correlated with use of the fore-extremities is declared by the extraordinary size of the myelo-brachial enlargement in birds, which depend on their fore-arms to raise and carry the entire burthen of their bodies, in birds, which walk, the pelvic enlargement is the greater of the two. It is true that the corpus striatum is unusually large in birds, forming the greater bulk of the hemisphere; and being, according to one theory, the motor terminal, it might have attracted notice in this discussion. But there is no allegation that the corpora striata are of unequal sizes in the human subject, nor has histological research taken particular notice of inequality in the cornua of the cervical enlargement, which might, however, reasonably be expected. Use might result in augmentation, but that use would not, in the spinal cord, be the consequence of unequal blood-supply, but the effect of volition, habit, and heredity.

There is, besides, another and more emphatic way of meeting all possible and impossible objections in reference to this question, which I will now state:—If right-handedness in man be due to the fact that one hemisphere of his brain is better supplied with blood than the other—if it be due, in any way whatever, to the mode in which the brachial and cephalic arteries come off from the aorta, then this conclusion is imperative: in every other animal, if any other there be, in which a similar vascular arrangement is found, there must be a similar exhibition of dextral predominance, or right-handedness. If not, then dextral predominance does not depend on vascular arrangement. Now, what are the animals which come into the same group with man, when classed by the standard of arterial identity in this region? They are: Monotremata (Ornithorynchus), many Marsupials (Phascolomys, Wombat), the Edentata (Bradypus, Dasypus), Hyperoödon, and Whales, Beavers, Rats, most claviculate Rodents, Seals, Prosimians (Tarsius), and the Chimpanzee.[14], [15]. To these must be added the

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[14] Owen: *Comp. Anat. and Phys. of Vertebrates*, vol. iii. p. 535.
[15] Gegenbaur: *Comp. Anat.* § 244.

Sirenia, where there is merely a wider space between the roots of the off-coming arteries, the arrangement of which remains essentially the same. Now, who will contend that these animals exhibit dextral predominance? Did it exist, it could not have escaped notice, more especially in the vast aquatic mammals, where, if anywhere, it should show itself on a large scale, where lob-sidedness would be so obvious to the observer, and so inconvenient to the sea-swimming creature.[16]

Take the question in another way, and test it by the structure of the animals in which authors assert dextral predominance to have been observed. Aristotle, and subsequently Pliny, assigned it to the lion and camel; the writer in the Encyclopædia to some dogs and horses; Dr. Ogle to monkeys and parrots. Now, in the lion both right and left common carotids come off equally from a common brachio-cephalic trunk, and therefore are beyond impeachment. Essentially similar is the disposition of the arteries in the horse. With respect to the monkeys, a few words of explanation are required. In the Chimpanzee the vascular arrangement has been noted as similar to that in man; but when monkeys are mentioned it is not this rather rare animal which is meant, but others of the group—those of the genus Inuus, including the Macaques, which are more commonly seen, and in which right and left carotids arise from a common brachio-cephalic trunk. Hence, if the statements made as regards the presence of dextral predominance in these animals be correct, this very remarkable conclusion is educed, namely: that dextral predominance exists in them, not on account of structure, but in spite of structure. The disposition of the arteries is such as to secure a fair and equal division of the blood-supply to the head, and yet they are represented as right-handed—if so, this must be by acquisition merely. But it is quite possible that the alleged facts were insufficiently, and therefore inaccurately, observed. Contradictions have been offered as regards both dogs and monkeys, and with these contradictions my own investigations coincide.[17] In every case it would require the most scrupulous vigilance to eliminate from such a test the influence which right-handed men may have had upon animals apt to imitate, and probably taught (more or less consciously) by their human attendant or proprietor.

The introduction of birds, as affording (in the parrot) an illustration of dextral pre-eminence, owing to structure, would have been avoided by a little reflection. The parrot has been the subject of training, and is very imitative: it uses not only both feet, but also the beak as a third

[16] The Rev. Dr. Haughton has noted the case of unequal lateral development in a seal in the Dublin Zoological Gardens, in consequence of which it swam in a circle.

[17] The Sphinx baboon in the London Zoological has been seen to fling projectiles with both hands. The Aye-aye, according to Mr. Bartlett, used only the left hand in feeding (Duncan—"Apes and Monkeys"—*Cassell's Natural History*, vol. i.): yet, in this animal, both carotids arise from a common branch of the brachio-cephalic.

organ of prehension. The fact that its right fore-arm ought to be stronger than its left, on the hypothesis given, is ignored; and it would be plainly antagonistic to the right conditions of flight, if one wing were weaker than the other. Indeed nothing, perhaps, more clearly shows the fallacy of the arguments in question than the fact that, whilst in birds we find a series of grades intermediate between two carotids and one sub-vertebral carotid—beginning with the median course of the right common carotid (in parrots) proceeding to fusion in a common trunk, and atrophy and disappearance of the right carotid beyond the point of fusion[18]—there should yet be that constant and perfect equi-potence of the fore-arms which is an essential condition to perfect flying. In the Dabchick the left carotid is the larger; in the Emeu the right; in the Apterix the left alone is found; in the Flamingo the right is single[19]—yet no corresponding differences have been recorded in the form and functions of the right and left limbs, anterior or posterior. The argument from birds thus fails of its purpose, and only survives to demonstrate that great vascular divergences may exist without being peripherically expressed by lateral differences.

III. Granting that a large amount of dextral predominance in man at present exists, it is doubtful whether it exists so universally and so completely as is assumed. Here I make elimination of persons distinctly recognised as left-handed, and speak only of the general mass designated right-handed people. Sir Charles Bell, Dr. W. Ogle, and others, maintain that the predominance extends to the right foot, which, according to Sir Charles Bell is first advanced in walking, and has a firmer tread: he adds, "the horseman puts his left foot into the stirrup, and springs from his right foot." Now, there is here a patent contradiction: for if in mounting, a man puts the left forward in order to spring from the right, then in walking he puts the right forward in order to spring from the left. But Bell, who accounts for his supposed fact, by the assumption that it was so ordained in order that there should be no hesitation as to which foot should be put forward, can never have witnessed recruits being put through the first rudiments of military drill. Untrained men show considerable diversity, and it is not without teaching that the proper foot is advanced, which here, as in dancing, happens to be the left. The left leg also is frequently shown advanced, in ancient art, *e.g.* in the Assyrian bas-reliefs. Those who are acquainted with the habits of spade husbandry are aware that most labourers employ the left foot in pressing the spade into the ground, which proves that it has a tread sufficiently firm for the purpose. If the opera-dancer, as Sir Charles Bell observes, performs "the most difficult feats by the right foot," the organ-player, on the contrary, gives the more difficult duty to the left foot. In proceeding to mount a horse, we advance to his left side, take the reins in the left hand,

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[18] Gegenbaur: *l. c.* § 244. [19] Owens, vol. ii., § 154.

place the left hand on the animal's neck, and the left foot in the stirrup. If the converse were the case, such facts would be immediately cited as illustrations of dextral predominance, and it would be shown that the right extremities had (as the left really have) to sustain and guide the ascending body, through different planes of motion. The right leg simply assists, though it largely assists, especially as it gives the initial propulsion.

When we consider, as in works of ancient or modern art, the position of a warrior on horseback, with weapon in his right hand, one is inclined at once to accept him as furnishing a marked instance of dextral predominance. So, likewise, a pacific rider, where the whip replaces the sword or spear. My mind was cleared to the true facts very simply: testing, with a dynamometer, the comparative strength of both hands in the case of a young gentleman, I found that his left was somewhat the stronger; and I asked him if he were not left-handed. He replied that such was not the case at all, but that he was very fond of hunting, which probably had strengthened the left hand. It immediately became obvious that, in riding, the left is the preferential hand; it is in constant action holding the reins, guiding, sustaining, or checking the horse. The right hand has usually but little to do, and nothing requiring skill, in peace. In war scenes, the presence of a weapon in the right hand diverts attention from the fact that the rider's life depends also upon the vigilance and alertness of his left hand—a fact recognised by the foe, who attempts to cut the reins. The ship is then rudderless, though its guns be still firing.[20]

Take, in this connexion, the case of a man who discharges a musket. The right keeps the butt to the shoulder, and draws the trigger; but certainly the duty performed by the left of maintaining the barrel steady and exact to aim, where the greatest precision is required, is not the less important. If it be asserted that the position of the gun is due to the predominance of the right eye, the nerve of which comes from the left hemisphere, that is counterpoised by the superior power of closing the left eye. The argument holds good, likewise, where the weapons were longbows or crossbows. Dr. Pye Smith has thrown out the speculation that people are right-handed because of the "survival of the fittest": those who presented the left or heart side to the foe being extirpated. But the conditions of such an intense struggle for life, requiring a dense, quarrelsome population, within a very limited area, cannot have existed at an early period of the earth's history. Besides, one-half of the population must have escaped

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[20] It is perhaps this predominance of the left hand, in riding and driving, which gave rise to the Rule of the Road, as quoted by Horne Tooke:—

"The Rule of the Road is a paradox quite:
In driving your carriage along,
If you go left, you are sure to go right;
If you go right, you go wrong."

that law, unless it be asserted that the women took equal part in every fray. Again, the proportion of heart-wounds needed would, of itself, put the proposition out of court. The early peoples flung rude missiles, with no very exact aim, or fought with their fists. Now, it is a remarkable fact that masters "of the noble art of self-defence" train their pugilistic pupils to advance the left side, the left foot, and the left hand, and that with this hand they are trained to strike; whilst they parry with the right hand, and rise on the right foot. There is thus a division of labour apportioned between the hands in the instances given; and the left has, in such cases, no inferior part, even in so-called "right-handed" persons. In stringed instruments, such as the violin, the instrument is placed on the left shoulder (not the right, as in the case of a gun), and the left arm is extended. The action of the right is so ostentatious that the performance would be classed under the head of dextral predominance, whereas the fingering done by the left has no secondary importance. A "right-handed" violinist would find it more difficult to train his right to fingering than his left to bowing. Such facts indicate an amount of precision, alertness, activity and delicacy in the left, rendering it an agent of great trustworthiness, whose services have been unfairly ignored. Even in that familiar art, where right-handedness is seemingly most manifest—namely, the manipulation of feeding-implements—the knife-hand simply cuts the food; whilst to the fork-hand is entrusted, not merely the task of holding the piece, but the duty of conveying it to the mouth. The Romans and Greeks, who reclined on couches at meals, must have been accustomed to use the uppermost, and therefore either hand, according to their position at the table. In primitive feeding-methods both hands are generally used, just as is the case commonly with animals which have prehensile fore-extremities. In a primitive art, such as knitting, the fingers of each hand are almost equally employed; in spinning, the left-hand, as it draws the flax from the "rock," had probably the superior function. In primitive occupations, such as threshing corn and breaking flax, the hands are alternately advanced. There is no art in which the right hand possesses so exclusive a domain at present as that of writing, yet there are sufficient indications that this was not so from the beginning. The cursive character has been shaped by and adapted to the right hand with us; but in ancient times (as in other countries) the characters were such as that they might have been more readily formed, and the implement more readily used, by either. The Greek and Latin terms for writing mean scoring or furrowing; and in that particular method which took its name from the turning of the ploughing ox, we are, I think, bound to believe that the right and left hands were used alternately in writing. All these things tend to prove that primeval man was ambidextrous; that in the lapse of years the operation of the principle of the division of labour rendered each hand specially apt for certain purposes. In most cases the more laborious duties, requiring greater strength, fell to the share of

the right hand, which, by constant practice, became the stronger. A tendency to develop in this direction was transmitted by inheritance.

This opinion is opposed to the view of Sir Charles Bell, who, straining the doctrine of design, considered that dextral preference was a "natural endowment," a "natural provision bestowed for a very obvious purpose"—namely, that "there should be no hesitation as to which hand is to be used or which foot ought to be put forward." Not, evidently, having given this subject a sufficient share of that keen observation which characterised his great intellect, he fell into some errors, as I have already shown: such of his reasons as remain to be met will give little difficulty. He argues that, "Everything being adapted (to the right hand) in the conveniences of life—as, for example, the direction of the worm of the screw, or of the cutting end of the augur—is not arbitrary, but relates to a natural endowment of the body." Granting that it is not arbitrary, I deny that it is universal. Anyone who possesses a Geneva watch is aware that it is necessary to wind it, not from left to right, as home-made watches are wound, but from right to left. During a sojourn in Paris one may experience vexation on account of this diversity in the theory and practice of screws; for, in winding a home-made watch with a French watch-key, the key (not being riveted) will unscrew itself, and come asunder in two pieces. Sir Charles Bell's reason would hold that the "natural endowment" of a right-handed Frenchman's body is the opposite of our own. But he advances another and a still more curious argument, when he says: "He who is left-handed is most sensible to the advantages of this adaptation from the opening of the parlour-door to the opening of a pen-knife." Plainly, Sir Charles Bell must have overlooked the fundamental law that a door-way is for exit as well as for entrance. If you come in through a portal, the door of which is "adapted" to the right hand, on going out again, the door will be found on the left—or "adapted" to the left hand. Of this theory one may say, *Solvitur ambulando.*

IV. Proceeding for the moment on the hypothesis that primeval man was ambidextrous, it remains to be considered in what way or ways dextral specialisation became a fact. Do we owe what we possess of it to inheritance wholly? Is it entirely the result of individual acquisition during early life? Or do we both inherit from ancestral acquisitions and personally acquire? We may reject the first supposition and the second. The first cannot be true, because it is unquestionable that, by special use and action, a member becomes more apt and strong within certain limits, and that this obtains as regards the right hand. Neither can the second be correct, for it ignores and excludes the principle of heredity, which is now well established. We, therefore, must admit an inherited tendency to specialise the right arm for acts requiring strength, whilst we must also insist on the existence of personal acquisition. Of this personal acquisition an infinitesimal portion may accrete to the human stock,

but the overwhelming mass of it perishes with the individual. Otherwise, long before this stage of the world's history, the disparity between the right and the left arms in a race of mechanics, such as smiths, would have become as great as the difference between the hind and the fore-legs of a kangaroo. This would be manifest in babies. But every baby is ambidextrous, in this point resembling the *αμφιδεξίος* heroes of Homer, and reviving thus the characteristics of the primal people in the world's youth. The trouble which arises to parents who insist on teaching children, at table, to hold the knife in the right hand,[21] is proof that no overmastering effort is produced by heredity. The child has no marked preference until taught; but it must be remembered that such teaching may come by the influence of example and the faculty of imitation, as well as in obedience to dictates. There is on record the case of a child, the offspring of a family all of whose members were right-handed for remembered generations, becoming left-handed when under the care of a left-handed nurse, and hen, when brought home, becoming right-handed.

We are bound, I believe, to accept the fact of an inherited tendency, but not to allow it undue influence. Is there any means or method of proving, demonstratively, the fulness of personal acquisition? The problem is, on the face of it, one of difficulty, because it would seem to involve the necessity of taking young children, and rearing them apart from all influence which might come to them from the words, example, arts or implements of the race. The details recorded of the peculiarities of so-called "wild men" are not sufficient for this object.

There is a method, however, which reaches to the end we desire to attain. Dr. Carpenter, in his characteristically able work on "Mental Physiology," called attention to the effect of fatigue and impaired nutrition in weakening memory by reducing the physical condition of the brain. An interesting illustration is given from the experience of Sir Henry Holland: "I descended, on the same day, two very deep mines in the Hartz mountains, remaining some hours underground in each," he writes. "While in the second mine, and exhausted both from fatigue and inanition, I felt the utter impossibility of talking longer with the German inspector who accompanied me. Every German word or phrase deserted my recollection; and it was not until I had taken food and wine, and been some time at rest, that I regained them again."[22] Now, we have here, from our view-point, an example and proof, showing that an acquired possession can be, and is, lost by exhaustion and impaired nutrition. To be more precise, it may be possible to say, that the more recent and extra-ordinary acquisition appears to go first. This is illustrated by the case of many Continental emigrants in America who, when near death, lose their acquired English, and speak in their original tongues; and more minutely in the

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[21] V. q. *Franklin:* A Petition of the Left Hand, p. 494. Philadelphia.

[22] *Holland*, p. 160, in Carpenter: *Mental Physiology*, p. 441, 1875.

case of an Italian gentleman, sick of yellow fever, who, at the begining of his illness, spoke English, in the middle of it French, and on the day of his death Italian only. The languages fell away from him apparently in the inverse order of their acquisition. The latest gained was earliest lost. Instances of acquired accomplishments disappearing, after illness, might be multiplied.

Now, to apply this pathological method. It has been my habit for several years to test, with a hand-dynamometer, the grasp-strength of patients when first seen, and at intervals afterwards. Originally, this system was adopted from the example of my late friend and instructor, Dr. Ducheme (de Boulogne) in cases of paralysis; but I generalised the practice, and have, of course, excluded all cases from consideration here, where loss of power might be due to any paralytic affection. The patients in question, male and female, suffered from different degrees of debility, arising from nervous depression, exhaustion, blood-impoverishment, &c., general or sometimes special causes affecting the constitution generally.

Having noted down the figures indicating the relative grasp-powers, dynamometrically tested, of right and left hands, it was obvious that the right arm reduced more in strength than the left. As cases accumulated, it became manifest that for a considerable series the rule is general, and may be established as a pathological law, of some interest and value. From thus simply testing the patient's power, it is possible to determine the existence of a discernible physical basis to his complaint; for it is plain that distinctions can be made—(*a*) where the grasp-power remains normal; (*b*) where it is somewhat reduced, and (*c*) where it is markedly diminished.

Cases where there has been considerable diminution may be separated into three groups or classes. In the first, or least-marked group, I place those in which the right hand still retains a strength superior to the left. On first testing, and if but once tested, it would be sometimes impossible to say if the patient were in truth physically depressed, though the lowness of the strength-standard would indicate this unmistakably in certain cases. The subsequent augmentation of strength, when ascertained by the dynamometer, suffices to put the matter beyond question.

In the second class are placed those cases where the index points to the same or to nearly the same standard for both hands. When this happens, it may be taken as certain that we are in presence of an abnormal condition: the right arm has suffered a loss much out of proportion to that experienced by the left. Subsequent investigations show that, as the patient recovers, the right regains its former predominance in power. In the third class, the pendulum is seen to have swung somewhat to the other side, for the grasp-power of the right has even become, by some pounds, inferior to that of the left. Nevertheless, here also, just as in the other groups, as the general health improves, the right hand steadily regains its old superiority in strength.

Now, bear in mind that we have it demonstrated, by the case of Sir Henry Holland and by other cases, that a personal acquisition, positively known to have been the earning of the individual himself, does fall off under circumstances of depression and exhaustion, and yet may be easily regained. When, therefore, we discover that the predominant strength of the right arm is amenable to the same fate, and subject to the same laws, we are compelled to conclude (having already eliminated all interfering arguments) that this dextral predominance is a personal acquisition also.

Reasoning back, it would appear that Primeval Man was ambidextrous. Nothing in his structure prevented this condition or suggested another. The simple occupations of the early world and those primitive arts which yet persist suited either hand or engaged both. Gradually, in the lapse of years, as occupations became more complex, the principle of the division of labour became more and more acted upon, and the functions of the hands became more specialised. This acquired habit of specialisation was transmitted by inheritance, constituting a tendency or predisposition in the offspring. As an aptness to learn languages may be transmitted, but not the languages themselves; so, a tendency to use the right hand for feats of strength was bequeathed, but not the strength itself. That is the acquisition of the individual. The ambidextrous child repeats in every generation the condition of the Primeval Man.

ILLUSTRATIVE CASES

SHOWING (*where general strength reduced*) *the relative grasp-power of hands, as tested by Charrière's Dynamometer,* (A.) *when first observed, and* (B.) *when health regained.*

When first observed, { In CLASS I. The right hand is somewhat predominant still. ,, II. Both are almost equal. ,, III. Right hand is the weaker. } Finally the right hand becomes distinctly predominant.

CLASS I.

	Right.	*Left.*
	lbs.	lbs.
A.	110	83
B.	205	150
A.	150	145
B.	165	150
A.	70	50
B.	160	95
A.	115	112
B.	140	125
A.	50	30
B.	145	95

CLASS II.

	Right.	*Left.*
Mr. N.:—		
	lbs.	lbs.
A.	100	98
B.	145	120
Mr. M.:—		
A.	115	112
B.	135	110
Miss V.:—		
A.	80	80·5
	95	85
B.	100	95
Rev. Mr. O'D.:—		
A.	100	100
B.	145	125
Mr. K.:—		
A.	125	122
B.	150	143

CLASS III.

	Right.	*Left.*
Rev. L.:—	lbs.	lbs.
A.	105	120
B	155	150
Rev. B.:—		
A.	83	96
B.	130	125
Mrs. M.:—		
A.	50	65
B.	104	106
Mr. M.:—		
A.	124	135
B.	152	140
Mr. M'D.:—		
A.	65	105
B.	130	116
Rev. B.:—		
A.	120	122
B.	203	147
Mr. C.:—		
A.	146	152
B.	207	156
Mr. P.:—		
	95	100
	145	145
Mr. M'C.:—		
A.	125	135
	145	140
B.	150	144

V.—Report on Irish Zoophytes.—Part I. On some Rare Sea Anemones taken at Greystones, Co. Wicklow, with Remarks on the Marine Invertebrate Fauna of that District. By H. W. Mackintosh, M.A., M.R.I.A., Professor of Zoology and Curator of the Museum of Anatomy and Zoology in the University of Dublin.

[Read, November 10, 1883.]

In the early part of 1878 I undertook to compile a list of the cœlenterata of the coast of Dublin, for the Guide Book published in connexion with the visit of the British Association to the metropolis. I became interested in the group, and in the beginning of 1882 resolved to extend my investigations, previously very limited, to other parts of the coast. In pursuance of this project I applied for and obtained a grant from the Academy, and having spent parts of the summers of 1882 and 1883 at Greystones, Co. Wicklow, I undertook a tolerably extensive series of dredgings, with a view to the collection of Zoophytes. In the course of my investigations I met with the Sea Anemones which form the first part of the present communication, and as my dredging operations covered a fairly large area, I have thought that it would not be out of place to record some observations relative to the marine invertebrata of the district.

The first of the Sea Anemones I have to notice is the splendid *Bolocera eques*, Gosse. The genus Bolocera was established by Gosse to receive a single species (*B. tuediæ*, Johns), nearly related to Tealia, from which it differs mainly in the non-retractility of the disc and tentacles. In the Appendix to his "Actinologia Britannica" Gosse described and figured, under the name of *B. eques*, another species which differs from *B. tuediæ* in having the tentacles completely, though peculiarly retractile, thus still further approximating to Tealia, but still possessing the facies of Bolocera. That *B. tuediæ* is distinct from Tealia cannot, I think, be doubted, the non-retractility of the disc and tentacles alone forming a well-marked distinction; but that *B. eques* is generically distinct from Tealia seems to me to be open to question, even though so skilled an actinologist as Gosse says that the discovery of this form "makes me better satisfied with the establishment of such a genus" [as Bolocera].

The specimen on which he founds the species was taken in "twenty-eight-fathom water about ten miles east of the mouth of the Tees": the specimen obtained by me was dredged in about twelve-fathom water, some two and a-half miles off Greystones, in a line with the Moulditch buoy (*vide* infra). Whilst its general resemblance to Gosse's figure and description was unmistakable, it differed from his example in having tentacles more of the modern shade of *ecru* than white; the red ring was well marked, as was the habit noted by Gosse of puffing

out the walls of the stomach, which showed the striped markings exactly as described by him. The tentacles were less mucronate and not so crowded as in his specimen, and altogether it approached very near Tealia—so near that, as I have said, I greatly doubt if it can be kept separate. I had it in a temporary aquarium for about a month, during which time it remained fully expanded, and, being some five or six inches across the top, presented a most beautiful appearance.

The second anemone to be noticed is *Stomphia churchiæ*, Gosse. The genus was formed by Gosse for the reception of an anemone first taken at Lough Long, afterwards at Peterhead, Moray Firth, and Scarborough, characterised by a column deprived of warts, a very protrusile disc, retractile tentacles, and no acontia; the mouth is "often widely opened," hence the generic name, and the colouration of the body is yellowish-white, flaked with scarlet. I dredged two specimens of this species near the Moulditch in about twelve fathoms; they both belonged to the variety *pyriglotta*, which, with the typical colouring, has short stout tentacles like those of Tealia. My specimens further resembled that genus in the striped colouring of the disc, which was not protrusile. The gape of the mouth was nearly of the ordinary dimensions. So far as my specimens were concerned, the affinities were entirely with Tealia, and but little, if at all, with Sagartia. I kept one specimen alive, and apparently in perfect health, for a month.

The third species to be noted is *Adamsia palliata*, Johnst. var. *Rhodopis*, Gosse. This peculiar anemone is found on Gasteropod shells, usually selecting one inhabited by *Pagurus prideauxii*; it will, however, survive for a considerable time after the hermit-crab has left. I kept the specimen I obtained for a month, having removed the hermit-crab from the shell on which it was perched, and at the end of that time the anemone seemed quite healthy. Two years ago I dredged a very fine specimen at Portrush, and being greatly struck by its beauty, seen for the first time, I kept it alive during my stay at Portrush, then brought it up to Dublin, and kept it in a small aquarium for several months, during which time it was deprived of the society of the crab with which it had previously lived. Both these specimens showed the peculiarity mentioned by Gosse, of secreting a brown semi-chitinous structure extending out from the mouths of the shells, which were too small for them. The species appears to occur pretty widely on the coasts of Great Britain, and has been found at Strangford Lough and in Bantry Bay. I have now to add the localities of Portrush and Greystones; I obtained the specimen at the latter place in about twelve-fathom water, a little north of the Moulditch buoy.

The last anemone I have to notice is *Aureliana heterocera* (Thoms.). This species was found between tide marks, near Cable Rock, by my young friend Master Frederick Wynne, the intelligent companion of my dredging trips. Gosse records two localities—Weymouth Bay, eight fathoms (W. Thomson), and Crookhaven, apparently in deep water (E. Perceval Wright). We made a careful search in the hope of finding the species again, but failed; however, as my informant gave me a

good description of it, and at once recognised the figure in Gosse's "Actinologia," I have no doubt as to the correctness of his discovery, and do not hesitate to add this pretty species to the fauna of Greystones.

I am thus able to record two species as new to Ireland, and two which, though not new, have been but rarely found. Doubtless careful search at Greystones will add more species to the list.

Passing on from this part of my Paper, I now proceed to give some details respecting the general marine invertebrate fauna, compiled from rough notes taken while in pursuit of a special subject.

The area over which I worked was, roughly speaking, a rectangle, commencing in a line with Cable Rock, at the southern point of Bray Head, and extending southward for six or seven miles, with a maximum distance from shore of about four miles and a-half. Within this area I made a large number of hauls, at varying distances from shore, beginning at about two hundred yards and running out thence to the distance mentioned. I also examined the shore line and as far as I could the shallow water near shore. This latter search, however, was not very easily made, as the water was seldom of that absolute smoothness required for a satisfactory exploration.

Before giving a list of the fauna, so far as I collected it, it will be desirable briefly to note the main features of the shore and sea bottom of this area.

Cable Rock runs out a short distance in the sea, then sloping back, rapidly gives place first to a number of large stones of Cambrian and quartz rock, which in turn are replaced by a beach of mingled pebbles and sand. This beach extends for about a mile and a quarter to the south, when it is interrupted at Greystones by a group of low cliffs of slates, grit, and quartz rock, the former being folded and contorted in very striking forms. This promontory has a base of between a quarter and half a mile, and is succeeded to the southward by another beach of pebbles and sand which extends to Wicklow, a distance of some eleven miles from Greystones. The general features of the sea bottom, so far as I can judge, are briefly these:—Opposite Cable Rock there is a considerable area of greyish mud. On a level with the North Strand, as it is locally called, there is nearer shore a bottom of coarse pebbles, merging into the rocks at Greystones: further out the bottom is rocky and very rough, a condition which is maintained up to the Moulditch Bank, a steep ridge running out about a mile and a-half in a direct line from shore, and rising to within a few fathoms of the surface. Beyond this the bottom seems to be composed, like the beach, mainly of pebbles of varying size, a character which it maintained as far as my investigations extended. From this brief sketch it will be readily seen that the shore offered but few advantages for collection. Pebbly beaches as a rule are barren ground, save for what may be washed in by onshore winds, aud the rocks were not of sufficient height or extent to afford good pools in which animal life could flourish. Hence, saving for the two common species of sea anemones, *Tealia crassicornis*, and *Actinia mesembrianthemum*, and shore crabs,

with an occasional small edible crab, the rocks were void of life, and along the strand sand-hoppers were the sole inhabitants.

The most profitable, though the most difficult, ground for dredging was the rough bottom between Cable Rock and the Moulditch Bank. Here a great variety would be brought up whenever a fairly long scrape of the dredge could be obtained; this, however, was by no means easy, as the bottom being very rocky the dredge continually got jammed, and the effort to free it frequently resulted in a foul, especially if the sea was at all rough. I made several attempts to work over this part in detail, but it so happened that on nearly every occasion when I tried the deep water three or four miles from shore, the wind and sea got up and put such a lift on the boat that it became impossible to get the dredge on the bottom without fouling, a circumstance mainly due to the lightness of both the irons and net. South of the Moulditch the ground is pebbly, and hence the animal life is not so varied. Lamellibranchs and Gasteropods were frequent, and enormous tufts of a Polyzoan (Gemellaria) were brought up together with quantities of a dark-purple ramified coralline, which must in some places completely cover the bottom.

I have now to give a more detailed account of the Invertebrates which came under my notice, premising that the list is only an approximate one, my chief object being, as stated, the collection of Zoophytes, my arrangements for stowage forbidding the attempt to keep all the material obtained.

Mollusca.—The Cephalopoda are represented chiefly by *Loligo magna*, which is taken by the fishermen in the siene nets. They usually fish from nightfall to daybreak, and the average sweep of the siene is from one to two hundred yards from shore; from this it would seem as if the squids came in towards land during the night. They are often taken in great numbers in the months of July and August; I have seen thirty or forty at one haul when the weather was calm. They are hardly ever caught at other times, one or two being found in May or June. They frequently reach a considerable size—one specimen at present in the Museum of the University measuring fully 16 inches from the apex to the origin of the tentacles. Occasionally, but very rarely, *Octopus vulgaris* is taken in the sienes, but this species seems to frequent deeper water than Loligo, and so is but seldom seen. Last August, when walking along the North Strand, I counted five successive hauls of Loligo, making a total of at least one hundred and fifty specimens, and in one of the larger hauls occurred a small Octopus, the only one I have seen; I was told by one of the fishermen that they are sometimes taken on the long lines during winter and spring. I do not know for what purpose the squids come in so close to shore; it can scarcely be for breeding, for I have seen bunches of their egg capsules in May, with the young animals fairly well developed, indicating their deposition some weeks earlier, and I have taken the capsules in water as deep as ten fathoms.

Of the Gasteropoda I noted the following species: Amongst Gymnobranchs two specimens of *Tritonia hombergii* were taken on

the rough bottom, half way between the Cable Rock and the Moulditch buoy; I failed to find any others, though I frequently searched the rocks round Bray Head at low water for the littoral species, and kept a fairly sharp look out on the contents of the dredge for the deep-sea forms. However, it is very likely that the minuter species may have come up attached to bunches of sea-weed, and escaped undetected, for I was unable to work over all the material with a lens. Of the shell-bearing Gasteropods the following were taken:—*Nassa reticulata*, *Neptunea antiqua*, *Fusus islandicus*, *F. propinquus*, *Murex arinaceus*, *M. corallinus* (scarce), *Buccunum undatum*, *Purpura lapillus*, *Natica catena* (fairly plentiful), *Velutina lævigata*, *Aporrhais pes-pelicani* (occasionally), *Turritella communis* (infrequent), *Trophon muricatus* (one specimen noticed, though others may have been taken, and overlooked owing to the small size of the members of this genus), *Trochus cinereus*, *Tr. zizyphinus* (very finely coloured specimens), *Pileopsis hungaricus*, *Littorina littorea*, *L. rubis*, *Patella vulgata*, *Helcion pellucidum*. Of the Polyplacophora, specimens of *Chiton cinereus* and *Ch. asellus* were not unfrequently obtained. Of the Lamellibranchiata the following representatives occurred: *Pholas dactylus* (rather scarce), *Saxicava anglia* (scarce), *Psammobia ferroensis*, *Tellina crassa*, *Venus gallina*, *V. fasciata*, *Tapes virginea*, *Cyprina islandica*, *Astarte sulcata*, *Ast. elliptica*, *Cardium rusticum*, *Cardium norvegicum*, *Cardium edule* (a single much-worn valve), *Pectunculus glycimeris*, *Mytilus edulis*, *Modiola sp.* (two very young specimens), *Nucula nucleus*, *Pecten maximus*, *Pect. varius*, *Pect. opercularis* (exquisitely coloured examples), *P. tigrinus*, *Hinnites pusio*, *Lima hians*, *Ostrea edulis* (of extremely large size), *Anomia ephippium*. This is a very scanty list, but its poverty is easily explained. The best ground for shells is the pebbly bottom south of the Moulditch Bank; but as this is barren of zoophytes, and indeed of nearly everything but shells, I always hauled the dredge as soon as we got off the rough ground and went northward again. I believe from what I saw that the malacological fauna of Greystones would prove decidedly rich if carefully explored.

Arthropoda.—Arachnida were represented by specimens of *Nymphon grossipes*, and *Pycnogonum*, which were frequently found amongst zoophytes, seaweeds, &c. The Crustacea included the following: *Stenorhynchus phalangium* (very abundant), *Hyas araneus*, *H. coarctatus* (one specimen), *Cancer pagurus* (in rock pools, and not unfrequently taken in the siene nets), *Carcinus mœnas*, *Portunus puber*, *P. pusillus* (common, and showing a considerable amount of variation in the prominence of the trilobed frontal process), *Ebalia Pennantii* (one female specimen), *Atelecyclus heterodon* (one specimen), *Pagurus bernhardus*, *P. prideauxii*, *P. cuanensis*, *P. ulidianus* (one specimen in a Trochus shell), *Munida rondeletii* (one young specimen, the rostrum being feebly developed), *Homarus vulgaris*, *Porcellana longicornis* (not uncommon in deep water), *Pandalus annulicornis* (frequent and very finely coloured), *Talitrus locusta*. The rough bottom between Bray Head and the Moulditch is rich in Decapods: a single haul of the dredge

yielded a number of specimens of *Port. pusillus*, *Ebalia pennantii*, *Atelecyclus heterodon*, *Porcellana longicornis*, and of course Paguri in abundance. On one occasion, when the sea was particularly smooth, I noticed several large shoals of the Megalopa stage of some crab, but of what species I do not know. I also observed a curious habit on the part of the shore crab which was new to me. A few miles south of Greystones there is an inlet of the sea which breaks up into a number of small branches ramifying over a considerable area, and of course rising and falling with the tide. In the larger channels are to be found sand-dabs in considerable numbers, and in the smaller channels I was surprised to see a good many specimens of the shore crab living side by side with numbers of gudgeon. The water in the main channels was, so far as I could judge, fairly pure sea water, that in the smaller channels was brackish; the communication with the principal channels was in many cases rather obstructed, and in this way I presume the addition of rain water from time to time rendered it brackish, the fresh water fish (which probably found their way in from some neighbouring ditch) and the marine crab becoming gradually acclimatised. Bell, in his "British Crustacea," alludes to the fact that the shore crab will survive immersion in fresh water, a power which apparently enabled the specimens I saw to resist the effects of the change from sea water to brackish water; their colour was exactly that of the sandy mud on which they lived.

Vermes.—My list of representatives of this sub-kingdom is very meagre, with the exception of Polyzon, of which I have obtained a good collection, but details of which I reserve for a future Paper. Of the Tunicata the best examples were obtained tolerably near the shore, where great masses of *Botryllus violaceus* were very abundant; *Aplidium fallax* was fairly frequent, and *Distoma rubrum* rather scarce; *Ascidia canina* and *Phallusia intestinalis* were also common, but of small size. The only other group of which examples were noticed were the Chœtopoda, represented by *Aphrodite aculeata* of small size and very dingy colouration; *Polynoë squamata*, *Nepthys margaritacea*, *Terebella medusa*, *Serpula triquetra*, and *Spirorbis communis*. A small piece of empty tube, probably belonging to a species of Pectinaria, was also obtained. Doubtless many others occurred in sea-weed, but I did not search for them.

Echinodermata.—As regards numbers this is the most abundant group, for Brittle stars were taken up simply by the dredge-full, and of the most exquisite beauty I have as yet seen. The species observed were: *Comatula rosacea* (scarce), *Ophiura texturata*, *Oph. albida* (both rather scarce), *Ophiocoma neglecta* (scarce), *Ophiocoma granulata* (not very common, but of remarkably large dimensions, and finely coloured, the disc being frequently marked with an orange star on a chocolate-brown ground[1]), *Ophiothrix rosula* (this species occurs in prodi-

[1] Forbes (Brit. Star-fishes) remarks that a variety of an orange colour is not uncommon in the Irish Sea.

gious numbers, of every conceivable variety of colouring; specimens were not unfrequently obtained with one arm of a totally different colour from the other four—for instance the disc and four arms would be uniform grey, and the fifth arm would be yellow; there was also a fine variety with the arms and part of the disc of a rich brownish-crimson, the rest of the disc being occupied with a brilliant yellow star), *Asterias rubens*, *Cribrella oculata*, *Solaster papposa* (very abundant, and sometimes reaching a very large size), *Asterina gibbosa* (not very common), *Echinus esculentus*, *E. miliaris* (both very common). Curiously enough I failed to obtain any Holothurians, although I cannot but believe that they are to be found on the rough bottom in deep water. My attempts to work over this part carefully were, however, foiled by the sea getting up suddenly, and rendering it futile to attempt to work over rocky ground.

Cœlenterata.—The Actinozoa were represented by the Sea Anemones, already described, and by the usual *Alcyonium digitatum*, which of course abounds in the rough gronnd. All the specimens I obtained varied from white to deep flesh-colour: none of the orange-coloured variety were taken. The Hydrozoa were represented chiefly by the Calyptoblastea; I have have as yet only cursorily examined the large mass of material I have collected, but I find that my list includes at least thirty species; in a future Paper I hope to give a full list of them. Of the other members of the group, the only species observed were *Rhizostoma pulmo*, *Aurelia aurita*, *Pleurobrachia pileus*, and *Pl. pomiformis*. I think the paucity of the pelagic Hydrozoa may be at least partly explained by the facts that the wind was almost invariably off shore whilst I was staying at Greystones, and that the sea is open and the tidal currents very strong off the coast. The free-swimming forms would thus be carried along by the currents, and kept well out at sea by the winds.

Polystomata.—Represented chiefly by the commoner species of Calcareous sponge, *Sycon ciliatum* (very large and abundant), and *Leucosolenia botryoides*, and amongst the Siliceous sponges by the protean *Halichondria panicea*, which was for the most part of the orange-coloured variety.

Protozoa.—I made no attempt to catalogue the members of this sub-kingdom, and hence the only forms which I noted were the various Foraminifera which were adherent to the zoophytes; these belonged chiefly to the genera Lagena, Nonionina, Polystomella, Rotalina, Globigerina, and Miliolina.

When it is considered that the foregoing list is compiled merely from hasty notes, taken while in pursuit of a special object, and cannot be regarded as more than a very rough approximation to a full list of the fauna, it will be apparent that the Marine Invertebrate fauna of this part of the coast offers as many attractions to the zoologist as does the surrounding country to the lover of rich and beautiful scenery.

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Part 14.—Report on the Acanthology of the Desmosticha. (Part III.) Further observations on the Acanthology of the Diadematidæ. By H. W. MACKINTOSH, M.A., M.R.I.A., Professor of Zoology, and Curator of the Museum of Anatomy and Zoology in the University of Dublin. (With Plates IX. and X.) [July, 1883.]

Part 15.—Expansion of Elliptic Functions. By WILLIAM NICOLLS, B.A. [April, 1884.]

[*For continuation of List of Publications, see page* iii. *of this Cover.*]

VI.—NOTES ON MICROPHOTOGRAPHIC METHODS. By RICHARD A. HAYES, M.D.

[Read, April 23, 1883.]

I HAVE the honour to lay before you some results obtained by me in Microphotographic methods, in great part accomplished by the aid of the grant accorded me by your Academy.

The object which I have had in view in my experiments was to obtain some simple and easily worked methods giving fairly uniform results. It will be easily understood that the chief difficulty which presents itself in Microphotography is to obtain a source of artificial light which shall at the same time have light-illuminating power, be perfectly steady, possess very active actinic properties, and be easily produced and maintained.

After considerable experience with electric (arc), magnesium, lime, gas and oil-lamp lights, I find that only the lime-light and the oil-lamp fulfil the necessary conditions, the use of the latter being confined to cases where the magnifying power does not exceed 50–100 diams.; or in other words, to the 1-inch or ½-inch objective. The difficulty as to the intensity of the light is not so much in reference to the exposure of the plate, as to the impossibility of getting the image focussed in a satisfactory manner, the great rapidity of the dry gelatine plates now in use making the time of exposure quite a secondary matter.

The arrangement by which the photographs exhibited were made is as follows:—In front of the condenser of the lime-light lantern is fixed a tube, 10 inches in length, at the further end of which is placed a plano-convex lens of about 2 inches focal length, mounted in a sliding tube movable by rack and pinion, the beam of light passing through which comes to a focus, and then while only slightly divergent falls on the achromatic condenser fixed in the sub-stage of the microscope. This arrangement gets rid of most of the heat rays, the beam passing through the condenser traverses the object to be photographed, the image of which is projected directly on the screen by the object-glass, no eye-piece being used. I have latterly invariably used for focussing a sheet of glazed white paper pasted on a glass plate placed in the dark slide, and as this is simply replaced by the sensitive plate, absolute coincidence of the focussing and sensitive surfaces is ensured. By focussing in this manner, as one sits in front of the screen, the various adjustments of the microscope and condensers are easily made, while keeping a distinct view of the image.

As regards the details of focussing the image, I have latterly adopted the following method:—

The object having been brought into the desired position and

roughly focussed, it is then by means of the mechanical stage removed from the field, and the diaphragm aperture which is intended to be used in the particular case having been placed in position, the achromatic condenser and light are manipulated until the field is evenly illuminated; the diaphragm plate is then revolved until the full opening is reached; the object is then brought back into position, and the best possible image obtained by means of the fine adjustment of the microscope: the diaphragm plate is then again returned to its former position; the image, of course, gains much in sharpness, and although quite sufficiently bright to produce an impression on a rapid plate, is not at all in as satisfactory a condition for accurate focussing as when presenting a brighter appearance.

When all the adjustments have been made, the sleeve suspended from the frame is placed in position, one end of it being attached to the sliding front of the camera, and the other end to a pasteboard cylinder, which fits on to the back of a narrow box, containing a sliding shutter by which the exposure is made; to the front of this box the body of the microscope is attached by a small black velvet sleeve which completes the camera: the large sleeve is made of Mackintosh cloth with three hoops fastened inside to prevent its collapsing.

The camera body and microscope are placed on a simple framework, which is grooved on top to allow the camera body to slide to any desired distance from the microscope. In order to obtain a constant amount of magnification with each objective, I mark on the framework the position of the camera body corresponding to so many diameters for each objective, this being ascertained by placing a micrometer on the microscope stage, and measuring the image on the screen with compasses.

All the photographs done by me lately have been taken on plates prepared by Mr. Fredman, chemist to Messrs. Bewley & Draper, and they have given me great satisfaction in every way.

As regards the exposures necessary, of course they will vary with plates of different makers: the plates which I have used are not so rapid as some made for instantaneous work, but as they are quite rapid enough and present several advantages, at least in my hands, I have preferred them to others of greater rapidity—in fact, the excessive sensitiveness of some plates is a positive disadvantage for this work, one of the defects complained of by those who have used them being the so-called "halation," which I have never had to complain of with Fredman plates. I give the shortest possible exposure necessary to secure a dense picture, and the pictures shown to-night were printed from negatives which received an exposure of 60 secs. for the 1-inch objective, and 90″–120″ for ¼″ obj. when using the lime-light.

I have not yet used an objective of higher power than ¼″: this gives a well-defined and satisfactory image of 200 diams. at a distance of about 30 inches from the screen (no eye-piece being used) and the pin-hole cap on the achromatic condenser. Similarly the 1″ obj. gives an image of 50 diams., with a similar distance between it and the

screen, good definition being obtained by using No. 3 aperture in the condenser diaphragm. I have confined my work to these powers as being representative of the objectives chiefly used in ordinary pathological investigations.

The microscope, as also the objectives and achromatic condenser used, are by Powell and Leland, the ¼" objective being a dry glass of low angle, and, from its possessing considerable penetration, is particularly suitable for photographic work.

With regard to the corrections usually described as necessary on account of the want of coincidence of the chemical visual foci, I have not found such corrections necessary. This in the case of the 1" objective is probably an accidental circumstance due to some peculiarity in that particular case by which the glass does not require correction; but in the case of the ¼" I was assured by Mr. Leland, when conversing with him on the subject a short time since, that he would not expect that the ¼ or any higher power would require any correction.

The only cases in which the oil-lamp can be satisfactorily used, so far as my trials go, is when a low power such as the 1" or ½" is employed. In one picture (shown) which was done in this way, and required five minutes exposure, the result is excellent.

Wishing to get the colour of the stained specimens on paper, in order to give an appearance as near as possible to that seen in the microscope, I applied to the Woodbury Company to make me some pictures by their gelatine process, employing gelatine coloured to represent carmine and logwood stains; they have succeeded admirably, and these prints can be produced in quantity at a very cheap rate—much cheaper than lithographing can be done in Dublin.

VII.—On the Geometrical Properties of the "Atriphthaloid." By the Rev. Richard Townsend, M. A., F.T.C.D.

[Read, February 27, 1882.]

Dr. Haughton has discovered the existence of a large family of curves in the course of his investigation of the form of a frictionless ocean, covering an attracting sphere.

The whole family he proposes to call *Atriptothalassic* curves, but one of them is so simple and elegant, that he has named it the *Atriphthaloid*, and requested me to undertake its discussion, which I have done in the following Paper:—

The equation of the *Atriphthaloid* in polar co-ordinates is

$$r^2(A - 2gr) = c^2 \operatorname{cosec}^2 \theta.$$

Putting for convenience of discussion, $A = 2gh$, $c^2 = 2gk^3$, and $\theta = 90° - \omega$, the equation of the curve assumes the form—

$$r^2(r - h) + k^3 \sec^2 \omega = 0, \tag{1}$$

where h and k are positive constants representing linear magnitudes, which may have any independent values from 0 to ∞, and which may be regarded as the parameters of the curve.

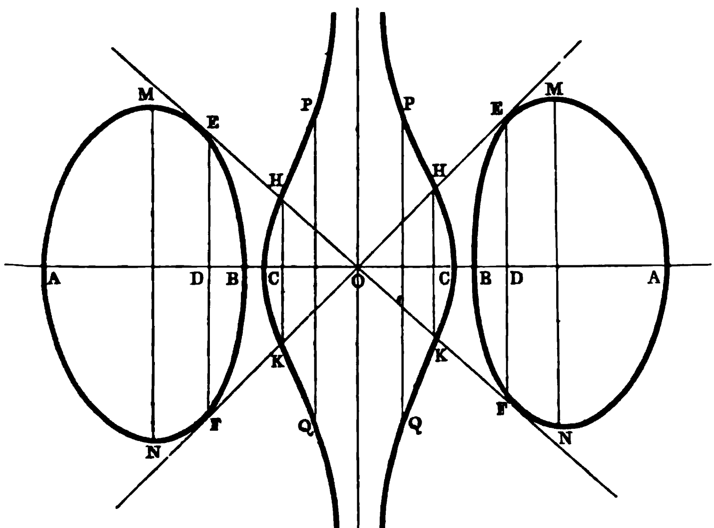
The equation (1) giving the same values for r when ω is changed into $-\omega$, or into $\pi \pm \omega$, we see at once that the curve it represents is symmetrical with respect to the two rectangular axes $\omega = 0$ and $\omega = \frac{1}{2}\pi$, and has a centre at the origin O (see fig.)

The equation (1) being, for every value of ω, a cubic in r whose absolute term is positive: hence, for every value of ω, r has one real negative value, commencing from its minimum absolute value OC when $\omega = 0$, and increasing continuously to ∞ from $\omega = 0$ to $\omega = \frac{1}{2}\pi$. Hence (see fig.), the two symmetrical conchoidal-shaped infinite branches, which always meet asymptotically on the axis for which $\omega = \frac{1}{2}\pi$, and which never disappear for any finite values of h and k however related to each other.

The remaining two roots of the cubic (1) for r in terms of ω being real or imaginary, by the theory of equations, according as $\sec^2 \omega$ is $<$ or $> \frac{4}{27}\frac{h^3}{k^3}$; hence, when $\frac{4}{27}\frac{h^3}{k^3}$ is > 1, the curve (see fig.), in addition to the two infinite symmetrical conchoidal branches which never disappear, has two finite symmetrical ovals, lying entirely outside the conchoidal branches, and intersecting the axis of x at two pairs of real

points A and B. The two tangents OE and OF to which from the origin O are given in position by the equation $\sec^2 \omega = \frac{4}{27}\frac{h^3}{k^3}$, and in magnitude by the equation $OE = OF = \frac{2}{3}h$, and the equal distances OD of their chords of contact EF from the origin by the equation $OD^2 = 3\frac{k^3}{h}$.

When $\frac{4}{27}\frac{h^3}{k^3} = 1$, then for the two tangents $\sec^2 \omega = 1$, and the ovals consequently contract into points whose equal distances from the origin $= \frac{2}{3}h$: the pairs of vertices A and B of the two ovals (see fig.) then coincide, and the equal distances OC of the two conchoidal vertices from the origin $= \frac{1}{3}h$.



When $\frac{4}{27}\frac{h^3}{k^3}$ is < 1, then for the two tangents $\sec^2 \omega < 1$, and therefore ω is imaginary. The two ovals then disappear altogether, and the curve consists entirely of the two conchoidal branches, which never disappear.

The sum of the three roots r_1, r_2, r_3 of equation (1) being independent of the value of ω, and $= h$ for all directions of r; hence, for the

two tangents, since $r_1 = r_2 = \frac{2}{3}h$ for the ovals, therefore $r_3 = -\frac{1}{3}h$ for the conchoidal branches. Hence (see fig.) the tangential radii OE and OF of the ovals, when real, are bisected at H and K by the conchoidal branches at their sides of the asymptotic axis of the curve.

The sum of the three products in pairs $r_2r_3 + r_3r_1 + r_1r_2$ of the three roots r_1, r_2, r_3 of equation (1) being also independent of ω, and equal 0 for all directions of r; therefore, for every three radii of the curve having a common direction, if r_1 and r_2 be those to either oval, and r_3 that to the infinite branch at the same side of the asymptotic axis, $r_3(r_1 + r_2) = r_1r_2$. Hence, for every three radii having a common direction, that to either infinite branch is in magnitude and direction half the harmonic mean between those to the oval at the same side of the asymptotic axis of the curve.

Differentiating equation (1) with respect to ω, we get

$$\frac{dr}{rd\omega} = -2k^3 \cdot \frac{\sin\omega}{\cos^3\omega} \cdot \frac{1}{3r - 2h} \cdot \frac{1}{r^2}, \tag{2}$$

which shows that $\frac{dr}{rd\omega}$ is $= 0$ only when $\sin\omega = 0$; that is, only for the three apsidal points A, B, C of the curve.

Hence the radius r of the curve has its maxima and minima values only at the three apsidal points on the axis for which $\omega = 0$, and the conchoidal branches have in consequence no dumb-bell depressions throughout their whole lengths.

Since, from the same equation (2), $\frac{dr}{rd\omega} = \infty$ when $\omega = \frac{1}{2}\pi$ and when $3r - 2h = 0$; therefore, as already observed, the axis for which $\omega = \frac{1}{2}\pi$ is an asymptotic tangent to the infinite branches, and the two radii OE and OF for which $3r = 2h$ are the two ordinary tangents to the ovals from the origin.

Putting, in equation (1), $x = r\cos\omega$ and $y = r\sin\omega$, that is transforming into rectangular co-ordinates, and solving for y, we get

$$y^2 = h^2 - x^2 - 2hk^3x^{-2} + k^6x^{-4}, \tag{3}$$

which shows that, for every finite value of x^2, y^2 has but a single finite value, positive or negative; that, from $x = \infty$ to $x = OA$, y^2 is negative, and therefore y imaginary; that, from $x = OA$ to $x = OB$, y^2 is positive and finite, and therefore y real and finite; that, from $x = OB$ to $x = OC$, y^2 is negative, and therefore y imaginary; and that, from $x = OC$ to $x = 0$ y^2 is positive and increasing from 0 to ∞, and therefore y real and increasing from 0 to ∞. These results obviously verify the form of the curve as obtained above from the equation for r (1).

Putting $y = 0$ in equation (3), we obtain for the squares of the three

semi-axes a, b, c of the curve, that is of the three distances OA, OB, OC of the three vertices A, B, C from the origin O, the cubic equation

$$x^6 - h^2x^4 + 2hk^3x^2 - k^6 = 0, \tag{4}$$

which has always one real positive root, and whose three roots when real are all positive.

N.B.—The equation (4) is, by the theory of equations, that whose roots are the squares of those of equation (1) for the case when $\omega = 0$.

Since from equation (1) when $\omega = 0$, by the theory of equations,

$$a + b + c = h, \qquad bc + ca + ab = 0, \qquad abc = - k^3$$

therefore

$$c = -\frac{ab}{a+b}, \qquad h = \frac{a^2 + ab + b^2}{a+b}, \qquad k^3 = \frac{a^2b^2}{a+b}, \tag{5}$$

and if d denote the distance OD (see fig.), since $d^2 = 3\,\dfrac{k^3}{h}$, therefore also $d^2 = 3\,\dfrac{a^2b^2}{a^2 + ab + b^2}$; relations which give the values of the four quantities c and d, h and k, in terms of a and b, and show consequently that the two latter quantities, which when real may have any independent values from 0 to ∞, determine completely all the particulars of the curve in every case.

In the particular case when $4h^3 = 27k^3$, that is when the two ovals contract into points, and when consequently $a = b$, equation (4) has two of its roots each $= \frac{4}{9}h^2$, and its third root $= \frac{1}{9}h^2$.

In the particular case when $h = 2k$, in which as $4h^3 > 27k^3$ the two ovals are real, the three roots of equation (4) are respectively $x^2 = k^2$, and $x^2 = \frac{1}{2}(3 \pm \sqrt{5})\,k^2$.

In the same case, those of equation (1), when $\omega = 0$, are respectively $r = k$, and $r = \frac{1}{2}(1 \pm \sqrt{5})k$; as they ought, the roots of equation (4) being in every case the squares of those of equation (1), when in the latter $\omega = 0$.

Putting in for h and k in the function $(4h^3 - 27k^3)\,k^3$, on whose sign as positive or negative it depends whether the ovals are real or imaginary, their values in terms of a and b as given by equation (5), we find readily that

$$(4h^3 - 27k^3)\,k^3 = \left[\frac{(2(a^2 + ab + b^2) + 3ab)\,ab}{(a+b)^2}\right]^2 (a-b)^2, \tag{6}$$

and that its sign is consequently, as it ought to be, positive or negative according as a and b are real or imaginary.

N.B.—The function in question being, by the theory of equations, the product of the squares of the differences of the roots of equation (1) for the case when $\omega = 0$, the same value for it in terms of a and b would be obtained even more readily than above by the substitution for c in that product of its value in terms of a and b. See equations (1) and (5).

Multiplying both sides of equation (3) by πdx, integrating between the limits a and b, and substituting in the result for h and k their values just given in terms of a and b; we get, for the volume V of the solid generated by the revolution of either oval round its axis of figure AB, the value in terms of a and b, viz.—

$$V = \tfrac{4}{3}\pi \left(\frac{a-b}{a+b}\right)^2 (a^3 - b^3), \tag{7}$$

which, compared with that of the volume S of the sphere on AB as diameter, viz., $\frac{1}{6}\pi (a-b)^3$, gives for the ratio of the two volumes in terms of a and b the value

$$\frac{V}{S} = 4\,\frac{a^2 + ab + b^2}{a + b^2}, \tag{8}$$

a value which, lying always between the extreme limits 3 and 4 corresponding respectively to the extreme values 1 and ∞ of the unrestricted ratio of a to b, shows, consequently, that the extreme depth MN is always greater than the extreme breadth AB of the ovals (see fig.)

That the chords of contact EF of the tangents to the ovals from the centre O of the curve (see fig.), which when the ovals are finite are of course always less than their extreme depths MN, are also in all cases greater than their extreme breadths, AB, may be readily shown from equation (6) as follows. Since

$$EF^2 = 4\,(OE^2 - OD^2) = 4\,(OF^2 - OD^2) = 4\left(\frac{4}{9}h^2 - 3\,\frac{k^3}{h}\right) = \frac{4}{9}\left(\frac{4h^3 - 27k^3}{h}\right);$$

therefore from equation (6), as $(a-b) = AB$, and as $hk^3 = a^2b^2(a^2 + ab + b^2) \div (a+b)^2$ by equations (5),

$$\left(\frac{EF}{AB}\right)^2 = \frac{4}{9}\,\frac{[2\,(a^2 + ab + b^2) + 3ab]^2}{(a^2 + ab + b^2)\,(a+b)^2}, \tag{9}$$

a ratio always exceeding unity, and having the extreme values $27 \div 9$ and $16 \div 9$ for the extreme values 1 and ∞ of the unrestricted ratio of a to b.

The value of MN in terms of a and b not being in general determinable like that of EF in finite terms, the exact value of the ratio of

MN to AB cannot consequently be given in general in such terms. As EF is never greater than MN when both are real, and only equal to it when both are evanescent, the least possible value of the ratio of EF to AB given by equation (9), viz., $4 \div 3$, is consequently an inferior though by no means a close limit to the possible ratio of $MN : AB$. But a superior as well as a closer inferior limit, both however much outside the extreme limits of the actual ratio, may be found for it from equation (7) as follows.

As the volume V of the solid generated by the revolution of either oval round its axis of figure AB must necessarily be less than that of the circumscribed cylinder, and greater than that of the inscribed double cone having AB for axis and the circle described by MN for base, we must therefore have, for all values of a and b,

$$\tfrac{2}{3}\pi\left(\frac{a-b}{a+b}\right)^2(a^3-b^3) < \tfrac{1}{4}\pi\,.\,MN^2.\,AB > \tfrac{1}{12}\pi\,.\,MN^2.\,AB,$$

and therefore, for all values of a and b, as $(a-b) = AB$,

$$\left(\frac{MN}{AB}\right)^2 < 8\,\frac{a^2+ab+b^2}{(a+b)^2} > \tfrac{8}{3}\,\frac{a^2+ab+b^2}{(a+b)^2}, \qquad (10)$$

from which it follows, consequently, that the square of the ratio in question must always lie between the extreme limits 2 and 8, its least and greatest values corresponding respectively to the least and greatest values 1 and ∞ of the unrestricted ratio of a to b. From the manner in which they have been obtained, however, these limits are obviously much outside of those of the actual ratio.

Differentiating equation (3) with respect to x, we get

$$y\frac{dy}{dx} = -x + 2hk^3x^{-3} - 2k^6x^{-5}, \qquad (11)$$

from which we get, for the values of x^2 for which $y\dfrac{dy}{dx} = 0$ and for which consequently y^2 is a maximum or a minimum, the cubic equation

$$x^6 - 2hk^3x^2 + 2k^6 = 0, \qquad (12)$$

which has always one real negative root for which x is consequently imaginary, and whose remaining roots will, by the theory of equations, be real or imaginary according as $8h^3 - 27k^3$ is $>$ or $<$ 0, and of the same sign when real. Hence the curve has never more than two values of x^2 for which y^2 is a maximum or a minimum; and as those values of x^2 lie necessarily, one between the limits a^2 and b^2 for which y^2 is positive, and the other between the limits b^2 and c^2 for which y^2 is negative, there is therefore never more than one pair of maxima

double ordinates to the curve which are real as regards both position and magnitude, viz., those MN of the ovals when real (see fig., page 63).

In the particular case when $4h^3 = 27k^3$, that is when the two ovals contract into points, the three roots of equation (6) are, respectively,

$$x^2 = \frac{4}{9}h^2, \quad x^2 = \frac{2}{9}(\sqrt{3} - 1)h^2, \quad \text{and} \quad x^2 = -\frac{2}{9}(\sqrt{3} + 1)h^2,$$

the first only of which gives a pair of chords real as regards both position and magnitude of the curve.

Eliminating x^2 between equations (3) and (12), we get, after a few ordinary reductions, for the actual maxima and minima values of y^2, the cubic equation

$$4y^6 - 8h^2y^4 + 4h(h^3 - 9k^3)y^2 + k^3(4h^3 - 27k^3) = 0, \tag{13}$$

which has always one real positive root corresponding to the real negative root of equation (12), and belonging consequently to no chords real even as regards position of the curve; and whose remaining roots will be real and have opposite signs when $4h^3 - 27k^3$ is positive, that is, when the two ovals are real and finite.

In the particular case when $4h^3 = 27k^3$, that is, when the ovals contract into points, one root of equation (13) is evanescent, and corresponds to the evanescent ovals; and the remaining two are respectively $= h^2(1 \pm \frac{2}{3}\sqrt{3})$; which correspond respectively, the former to the real negative root of equation (12) and therefore to no real chords even as regards position of the curve, and the latter to the pair of chords between the evanescent ovals and the infinite branches, which, though real as regards their positions, have no real intersections with the curve.

Differentiating with respect to x the value of $\frac{dy}{dx}$ given by equation (11), having first substituted in it for y its value in x given by equation (3), and equating the result to 0, we get, after a few ordinary reductions, for the values of x^2 for which $\frac{d^2y}{dx^2} = 0$, that is, for the several points of inflexion, real or imaginary, of the curve, the equation of the sixth degree,

$$x^2\left[h^2x^{10} - 12hk^3x^8 + 3k^3(2h^3 + 5k^3)x^6 - 18h^2k^6x^4 \right. \\ \left. + 18hk^9x^2 - 6k^{12}\right] = 0, \tag{14}$$

of whose roots one is obviously evanescent, one essentially real and positive, and the remaining four when real essentially positive also.

The evanescent root corresponds of course to the axis of y, which is consequently a doubly inflexional as well as asymptotically tangen-

tial chord of the curve, and the essentially real and positive root to the pair of inflexional chords PQ (see fig.) of the conchoidal branches; which, equidistant in opposite directions from the axis of y, lie necessarily somewhere between it and the parallel tangents at the vertices C of the branches.

The four remaining roots, with the four pairs of inflexional chords reflexions of each other with respect to the axis of y to which they correspond in the curve, may be all real, or all imaginary, or two real and two imaginary, according to the particular value of the parametric ratio $h \div k$ on which alone they depend. When the two ovals are real and finite, as they are for all values of the ratio for which $4h^3 > 27k^3$, the entire number of pairs of inflexional chords intersecting them at pairs of real points is necessarily even; but none of the four pairs, even when themselves real as regards their positions, need intersect them necessarily at real points at all. So that the ovals may be, and in fact often if not always are, as represented in the figure, concave to their interiors throughout the entire circuits of their perimeters.

The application of Sturm's theorem to equation (14) gives us, for all numerical values of the parametric ratio, the exact numbers of corresponding pairs of inflexional chords which occupy real positions within any two assigned limits of distance from the centre O of the curve; and, as the corresponding values of OA and OB can also be determined for all such values to any degree of approximation, from equations (1) or (4), by Horner's and other methods of numerical solution, the exact numbers of real pairs of inflexional chords lying within the intervals AB, and therefore intersecting the ovals at real points, can consequently be determined by its aid for all numerical values of the ratio. Its applications, however, are in general laborious, and in the present instance uninstructive except for such values of the ratio.

By its application to the equation for the two particular cases when $h \div k = 1$ and 2 respectively, which correspond, the former to an imaginary and the latter to a real pair of ovals; we find, with comparatively little trouble in either case, arising from the circumstance of the quadratic functions having imaginary roots in both, and therefore dispensing with the necessity of proceeding any further with the process in either, that the equation, in addition to its evanescent, has for each of them but a single real root, that, viz., corresponding to the pair of inflexional chords of the infinite branches which are always real. And, by a similar application, attended with a little more trouble arising from the reality of the roots of the quadratic functions in each case, we arrive at the same result for the two cases when $4h^3 = 26k^3$ and $28k^3$ respectively, which correspond again, the former to an imaginary and the latter to a real pair of ovals; the intermediate case for which $4h^3 = 27k^3$ being that for which they pass through evanescence from their real to their imaginary state, and conversely.

In the particular case when $4h^3 = 27k^3$, for which the ovals contract into points, the five finite roots of equation (14) are on the contrary

all real, and correspond in consequence to five pairs of chords all real as regards their positions; one of which intersects, as in all cases, the conchoidal branches, and, of the remaining four, three coincide at the evanescent ovals, and the fourth intersects the curve at imaginary points.

For, equation (14) for x^2 is easily seen to be equivalent in that case to

$$h^2 x^2 \left(x^2 - \frac{4}{9} h^2\right)^3 \left(x^4 - \frac{4}{9} h^2 x^2 + \frac{1}{6}\left(\frac{4}{9} h^2\right)^2\right) = 0, \qquad (15)$$

which, besides its single root = 0, has evidently three roots each $\frac{4}{9} h^2$, and two others equal respectively to

$$\frac{2}{9} h^2 \left(1 \pm \sqrt{\frac{1}{3}}\right);$$

which correspond respectively, the first three to the evanescent ovals, the latter with the lower sign to the conchoidal branches, and the latter with the upper sign to no real points at all on the curve.

Of the three pairs of chords coinciding at the evanescent ovals in this case, two however correspond to the evanescent radii of curvature at their vertices; the function $-y^3 \frac{d^2y}{dx^2}$, which multiplied by x^{10} is manifestly equivalent to the quantity within the brackets at the left side of equation (14), representing in all cases, as is well known, at the several vertices of any curve symmetrical with respect to the axis of x, the squares of the corresponding radii of curvature at the vertices, and being consequently evanescent at the two coincident vertices of every acnodal double point on the axis of the curve.

As regards the third pair in the same case. Taking it in connexion with the pair intersecting the curve at imaginary points, and conceiving both pairs to change position together with the gradual and continued increase of the parametric ratio from its critical to every higher value, and the consequent accompanying dilatation of the ovals from their evanescent to every greater magnitude; they are to be regarded, while real, as two variable pairs of inflexional chords intersecting the expanding ovals at pairs of imaginary points, and after coming together in the course of their variation, as the above particular cases show they do very rapidly with the increase of the ratio, then passing through coincidence from their real to their imaginary state, beyond which the particulars above stated supply no clue to follow them.

N.B.—The questions, as to whether for any values of the parametric ratio the ovals have ever real points of inflexion, and as to the critical values (if any) of the ratio for which they cease (if ever) to be, as represented in the figure, concave to their interiors throughout the entire circuits of their perimeters, have, it will be observed, been left undecided in the above investigation.

VIII.—CRITICAL AND LITERARY REMARKS ON EUCLID'S DOCTRINE OF PARALLEL LINES. By REV. SAMUEL HAUGHTON, M.D.; F.R.S.; S.F.T.C.D.

[Read, February, 11, 1884.]

PROFESSOR CAYLEY, President of the British Association for the advancement of Science, in his Address delivered at Southport, 1883, ably defended the position that Euclid's Doctrine of parallel lines truly rests upon an axiomatic or self-evident base, which is as follows:—

"If a right line falling upon two right lines make the internal angles on the same side less than two right angles; these lines produced to infinity will meet on the side on which the angles are less than two right angles."

On the day following the President's Address, I called his attention to the fact, that he had defended Euclid beyond what he required, because the best MSS. placed the foregoing statement among the Postulates and not the Axioms. Euclid proves absolutely (I. 17), that any two angles of a triangle are less than two right angles; and he requires the reader to grant him the converse of this proposition, as the necessary base of the doctrine of parallel lines. Some minds will grant the converse as self-evident, others will accept it as an unproved condition, on which Euclid proceeds to construct his doctrine of parallels.

I have examined the old editions of Euclid in the Library of Trinity College, and find the following results:—

The following editions place the proposition among the Postulates:—

1. J. Campanus[1] (Venice), ...	1482
2. B. Zamberti[2] (Paris), ...	1516
3. Orontius (Paris), ...	1544
4. Billingsley (London), ...	1570
5. Commandinus (Pesara), ...	1572

The following editions place the proposition among the Axioms:—

1. Grynæus (Basle),[3]	1533
2. Dasypodius (Strasburg), ...	1564
3. Candalla (Paris), ...	1566
4. Clavius (Rome), ...	1574

The best edition of Euclid yet published is that of F. Peyrard,

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[1] This is a Latin translation from the Arabic [Editio princeps.]

[2] A Latin translation.

[3] [Editio princeps.]

Paris, 1814, in Greek, Latin, and French, mainly based upon a very ancient MS. which had remained unknown until examined by Peyrard.

This MS. (190), may be called the Vatican, as it formerly belonged to that Library, and was sent from Rome to Paris by the Comte de Peluse.

This MS. bears all the characters of the end of the ninth century, while all the other MSS. belong to much more recent times. It is remarkable that the Vatican MS. places the base of the doctrine of parallel lines among the Postulates and not among the Axioms; and the Arabic text translated by Campanus seems to have been taken from some old source similar to the Vatican MS.

We may, therefore, as I think, reasonably conclude that Euclid shared the opinion of the moderate geometers, who think that the foundation of the doctrine of parallel lines is not self-evident, but takes the form of a Postulate, equivalent to the converse of the seventeenth of the first.

IX.—ON THE HEIGHTS ATTAINED BY PLANTS ON BEN BULBEN. By the late THOMAS HUGHES CORRY, M. A., F. L. S.*

[Read, December 10, 1883.]

MR. CORRY had received from the Academy, in 1882 and 1883, a grant for the exploration of the Botany of the Ben Bulben Range of Mountains, and it was in carrying out this undertaking that he met with the accident which caused his premature death. He and his companion, Mr. Dickson, were drowned by the upsetting of their boat in Lough Gill, near Sligo, in the month of August last.

Mr. Corry's career as a Botanist was only just commencing, but he had already given great promise of distinction as a scientific Naturalist. Himself an Irishman, he took the greatest interest in the Botany of the country. His remarkable zeal and energy, his love for the study of critical plants, together with the position which he held as Curator in the Herbarium at Cambridge, and as the trusted friend of Professor Babington, gave him unusual advantages, of which he diligently availed himself; and his early death will be deplored by all who feel an interest in the advance of Botany in Ireland. One of his best contributions to the subject is an account which he published of a tour made in Clare in 1879. He also wrote several short articles chiefly relating to Irish plants for the "Journal of Botany," and, at the time of his death, had made preparations for printing a Flora of North-eastern Ireland.

Owing to the unexpected death of Mr. Corry, at the very time when he was commencing a second exploration of the Botany of Ben Bulben and its neighbourhood, his notes and manuscripts were left very incomplete, the more so because he had postponed writing any detailed account of his work until he should have finished his intended examination of the whole range, both in Sligo and Leitrim, and therefore he had not yet put together any connected narrative of the expedition which he made, with his friend Mr. Dickson, in 1882.

Under these circumstances, it has been thought best to extract only the heights, as found carefully noted by Mr. Corry, in the copy of the "London Catalogue of British Plants" which he carried with him. As his researches were almost entirely confined to the county of Sligo, and as there is no mention of Truskmore Mountain in his notes, it will probably be safe to take 1963 feet, the summit of Ben Weisken, as the highest point of the range explored by him. From the capital letters B, W, K placed opposite many of the species, he appears to have visited the three mountains, Ben Bulben, Ben Weisken, and King's Mountain (or Knocknaree), also Glencar, and a mountain opposite King's Mountain.

Of the twenty-three Alpine species previously known as occurring on this range, it will be seen that Mr. Corry gathered eighteen, and

* Communicated by A. G. More, F.L.S., M.R.I.A.

himself added to the list *Salix herbacea* and *Carex rigida*. The few mountain plants not marked in his list, recorded by other botanists on Ben Bulben, are:—

Drapa rupestris.	Thalictrum alpinum.
Saxifraga oppositifolia.	Alchemilla alpina.
Lycopodium alpinum.	

Respecting the last two, it may be well to mention that there is some doubt whether a form of *Thalictrum minus* may not have been mistaken for *T. alpinum*. The *Alchemilla alpina* recorded by Mackay proves to be *A. conjuncta*, and grows in a suspicious situation, where it cannot be considered native.

In the following List, the word "top," when accompanied by the capital letter B, is to be understood as referring to the top of Ben Bulben (1721 feet). And though some may not have occurred on the actual summit, none probably were gathered lower than 1600 to 1700 feet. All the heights exceeding this are, in Mr. Corry's list, accompanied by a capital letter W, and appear to have been taken on Ben Weisken only. The Alpine species are printed in italics, and the names of the plants are arranged in a descending series.

List of Species and Heights.

Species.	Heights.
Oxalis acetosella,	W. top, 1900, B. top.
Primula vulgaris,	W. top, 1900, B. top.
Viola sylvatica,	W. top, B. top.
Alchemilla vulgaris,	1900 and B. top, 1100.
Potentilla tormentilla,	1900 and B. top, 650.
Pinguicula vulgaris,	1900 and B. top, 1100.
Empetrum nigrum,	1900 and B. top, 650.
Sedum rhodiola,	1900 and B. top, 1175, 1150.
Chrysoplenium oppositifolia,	1850 and B. top.
Linum catharticum,	1850 and B. top.
Galium saxatile,	1850 and B. top, 1175.
Veronica serpyllifolia,	1850 and B. top.
Eriophorum vaginatum,	1850 and B. top.
Asplenium viride,	1850 and B. top, 1200, 1000, 900, 100.
Cystopteris fragilis,	1850 and B. top, 1200, 1000.
Lycopodium selago,	1850 and B. top.
Arabis petræa,	1850.
Draba incana,	1850 and B. top, 1500, 1100, 900, 1300, also at sea level on sand hills.
Arenaria ciliata,	1850, 1400.
Lotus corniculatus,	1850, 1200.
Saxifraga nivalis,	1850 (7 plants only).
S. hypnoides,	1850, 600.

SPECIES.	HEIGHTS.
Bunium flexuosum, ...	1850.
Melampyrum pratense, v. montanum, ...	to 1850.
Eriophorum angustifolium, . .	1850.
Poa alpina, ...	1850, and top only of Ben Bulben.
Ranunculus repens, ...	1800.
Silene acaulis, ...	1800, and B. top, 1150, 1100.
Saxifraga aizoides, ...	1800, and B. top, 1100, 900, 600.
Cardamine pratensis, ...	1800, 1575.
C. sylvatica, ...	1800, 1575.
Arabis hirsuta, ...	1800, 1200, 1100, 900, 600.
Carex sylvatica	1800.
Asplenium ruta-muraria, . . .	1800, 900.
Ranunculus repens, ...	B. top, 1575; 1800, W.
Cochlearia alpina, ...	B. top, 1200.
Polygala vulgaris, v. grandiflora, .	B. top, 1175, 900.
Silene maritima, ...	B. top.
Lychnis diurna, ...	B. top, 700.
Cerastium triviale, ...	B. top.
Alsine verna, ...	B., near top.
Sagina procumbens, ...	B. top.
Vicia sepium, ...	B. top.
Geum rivale, ...	B. top, 1150.
Dryas octopetala, ...	B. top, 1150.
Angelica sylvestris, ...	B. top.
Chærophyllum sylvestre, . . .	B. top.
Viburnum opulus, ...	B. top.
Scabiosa succisa, ...	B. top.
Bellis perennis, ...	B. top.
Taraxacum officinale, ...	B. top.
Crepis paludosa, ...	B. top.
Campanula rotundifolia, . . .	B. top.
Vaccinum myrtillus, ...	B. top.
Veronica officinalis, ...	B. top.
,, chamædrys, ...	B. top.
Euphrasia officinalis, ...	B. top.
Pedicularis sylvatica, ...	B. top.
Thymus serpyllum, ...	B. top.
Rumex acetosa, ...	B. top.
Oxyria reniformis, ...	B. top, 1200.
Polygonum viviparum, ...	B. top, 1200, 600, 500.
Salix phylicifolia, ...	B. top, 1200.
,, var. nitens, ...	B. top, 1200, 1100.
S. herbacea, ...	B. top.
Orchis maculata, ...	B. top.
Luzula sylvatica, ...	B. top.
Scirpus cæspitosus, ...	B. top.

Species.	Heights.
Carex glauca, ...	B. top.
Pteris aquilina, ...	B. top.
Asplenium trichomanes, ...	B. top.
Aspidium lonchitis, ...	B. top, sparingly; 1250, 1150.
Nephrodium filix-max, ...	B. top.
,, dilatatum, ...	B. top, 1500.
Polypodium vulgare, ...	B. top.
Fragaria vesca, ...	1550.
Carex pulicaris, ...	1500, 1400.
,, binervis, ...	1500, 1300.
Luzula multiflora, ...	1475.
Thalictrum minus v. montanum, .	1474, 1150, 1100.
Parnassia palustris, ...	1450, 200.
Carduus palustris,.	to 1400.
Plantago maritima, ...	1400, 1000, 900.
Urtica dioica, ...	1400.
Salix aurita, ...	1400, 900.
Carex rigida, ...	1400.
Listera ovata, ...	1350, 1150.
Polygala oxyptera, ...	1300, 1100, 1175.
Rosa spinosissima, ...	1300, 900.
Hieracium pilossella, ...	1300.
Hieracium anglicum, ...	1300, 1175, 900, 600.
,, murorum, ...	1300, 1200.
Juniperus nana, ...	1300, 1200.
Orchis mascula, ...	1300.
Carex pilulifera, ...	1300, 1200.
Meconopsis cambrica, ...	1250, 1100, 1000, 500.
Ilex aquifolium, ...	1200, 300.
Trifolium pratense, ...	1200.
Pyrus aucuparia, ...	1200.
Hedera helix, ...	1200, 900.
Hieracium iricum, ...	1200.
H. gibsoni, ...	1200, 1100.
Corylus avellana, ...	1200.
Taxus baccata, ...	1200.
Koeleria cristata, ...	1200, 1150.
Selaginella selaginoides, ...	1200, 200.
Hypericum pulchrum, ...	1175.
Rubus saxatilis, ...	1150.
Allium ursinum, ...	1150.
Asperula odorata, ...	1100.
Valeriana officinalis, ...	1100, and base.
Alnus glutinosa, ...	1100.
Cystopteris fragilis v. dentata, .	1100 500.
Nephrodium æmulum, ...	950, 700, 300.
Pyrus rupicola, ...	920.

Species.	Heights.
Hypericum androsæmum, . . .	900.
Arctium intermedium, ...	900.
Solidago virga-aurea, ...	900, 950.
Sonchus asper, ...	900.
Erica cinerea, ...	900.
Scolopendrium vulgare, ...	900, 950.
Solidago virga-aurea, v. cambrica,	800.
Arum maculatum, ...	700.
Anemone nemorosa, ...	to 650.
Gymnadenia albida, ...	680, 575, 300.
Listera cordata, ...	650.
Euonymus europæus, ...	575.
Stellaria graminea, ...	550.
Pyrola media, ...	550.
Circæa alpina, ...	500.
Sedum telephium, v. fabaria, . .	500. (?)
Sanicula europæa, ...	500.
Fraxinus excelsior, ...	500.
Betula alba, ...	500.
Orchis incarnata, ...	500, 200.
Salix caprea, ...	500.
Carex pallescens, ...	300.

Among the more interesting species noticed, Mr. Corry marks the following as new to District 9:—

Ranunculus penicillatus.
Rosa arvensis, var. bibracteata.
Salix fragilis.
S. alba.
S. herbacea.
†S. triandra.
‡S. purpurea.
†S. Smithiana.
Potamogeton rufescens.
*Elodea canadensis.
Listera cordata.
Luzula pilosa.
Blysmus rufus.
Carex vulpina.
C. rigida.

X.—On a Mode of Sub-aqueous Tunnelling. By Sir Samuel Ferguson, Q.C., LL.D., President.

[Read, December 10, 1883.]

Tunnels under water-ways have always hitherto been constructed by driving a masonry-built culvert through the subjacent strata.

The conditions most favourable for such works are where the strata are impervious to water, as rock, chalk, or tenacious clay. Those least favourable are, where the river bottom consists of mud, sand, or gravel; and it may be doubted if engineering skill at present would be equal to the construction of a drift tunnel through any considerable flow of free water.

But the more unfavourable such conditions are for the drift tunnel, the more they seem to invite to another method which would appear sufficiently practicable to make it worth the attention of engineers, and which may be thought to involve enough of scientific speculation to commend it to the attention of a learned society.

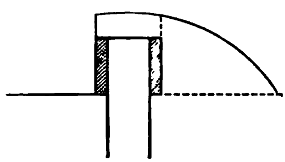
It is simply the deposit, by sinking, of an iron-built tubular subway, which, after being settled in its bed in the river bottom, should be pumped out and connected with the underground approaches.

A tidal river or estuary, in which the work should be kept out of the way of navigation, will best illustrate the proceedings which should be taken in carrying out such an operation. Let it be required to sink such a subway under the navigable bed of a tidal river having a bottom of mud, sand, gravel, or other material easily dredged; a depth say of 16 feet in mid-channel at low water, and a width of 400 feet between walled wharves, up to which the approaches are assumed to have been executed, having their roadways 22 feet below the river bottom, and terminating in cross-walls of wood or puddle at the back of the quay wall at either side; and let the tunnel be 16 feet in height under 6 feet of solid material between the crown of its arch and the deepest part of the river channel.

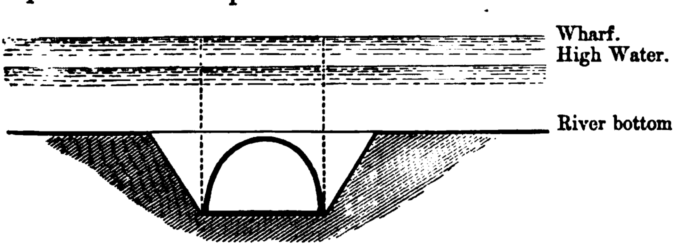
The operations would consist—(*a*) in the excavation of a transverse trench in the bed of the river in the line and down to the level of the roadways of the approaches; (*b*) in the preparation, at either end, of recesses on the face of the wharf wall, down which the ends of the tubular tunnel should be guided in its descent into the trench so prepared; (*c*) in the construction of the iron tubular tunnel, having a flat floor and arched section, floating it into position, sinking it into its bed, and making good the river bottom alongside and over it; (*d*) in luting the tube at either end in the recesses, and pumping it and them out; and (*e*) in cutting away the cross walls and completing the connexions.

Each operation would have its own practical difficulties. A level bottom under the tube (in this case supposed to be a straight bar) would be essential, as well for the avoidance of strains as for the

sake of adhesion, without which the tube, on being pumped out, would rise by flotation. It is conceived, however, that a level bed, once obtained, could be effectually kept from being silted up, pending the deposit, by several methods, and that the weight of the tube on a soft bed would ensure such an amount of adhesion as, even without that of the lateral and superincumbent material, would effectually counteract the tendency to rise; and this envelope would consolidate with time. The point at which the floating action of muddy water ceases, and the adhesive and repressive action of watery mud or silt begins, has not, I imagine, been made the subject of accurate investigation. Water acting on large surfaces, although admitted through narrow orifices, exerts pressure proportionate to its head; but the limit of tenuity where percolation ceases to carry with it the action of a continuous column of fluid, appears to be undetermined. It is conceived, however, that it would be found at a point short of that where the mixture reaches a pasty consistence. The preparation of recesses for guiding the descent of the tube would entail the employment of cofferdams, within which sills should be laid level with the floor of the trench. The sides of the recesses should be carried back to the cross walls, and, at a point under the level of high water and lower than the draft of the tunnel when floated, the alternate check at either side should be retired, to admit of the reception of the ends of the tube, necessarily longer than the breadth of the waterway.



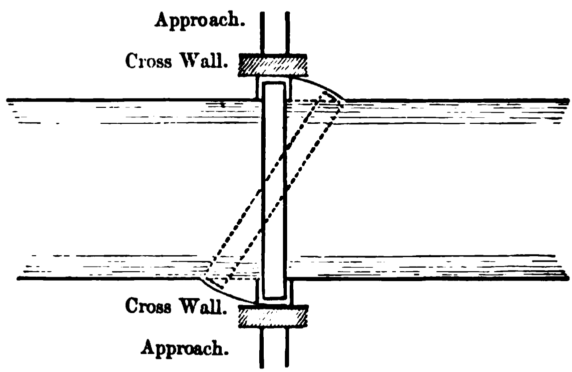
The construction of the tubular tunnel itself might either be in a dry dock specially prepared for it, which would be hard to procure, or on a raft, or by sections of a convenient length built on land and launched, connected together and fitted with sides and roof in a wet dock or other still water. Such sections should constitute shallow, open vessels of no greater freeboard than would ensure their floating, so that the subsequent work on the platform so formed should be continuous and



rigid. The ballast necessary to keep the tube upright would be supplied by the metalling required for the roadway, or, if this were not sufficient, by admission of water. To secure such a tube against the action of salt water it should be bronze-plated externally, and its

thickness should be such as would resist the pressure due to the depth of the trench and of the supernatant water. Or it might be constructed with double sides and roof, between which a coating of concrete might be introduced from above.

The floating of the tube into position should be accomplished at high water, when, its ends being brought home to the down-stream check of one recess and the up-stream check of the other, with such arrangements to prevent jamming as might be necessary, the water would be admitted through its length by valves, and it would sink evenly down its guide-chambers to the bottom. This accomplished,



the process of filling in and making good the bed of the river would take place.

The luting of the ends of the tube would be effected by puddling between it and the masonry of the recesses, and the process of pumping out would be proceeded with.

To complete the connexions, the cross walls at the ends of the approaches should be cut through, and the ends of the tube being removed, the way would be open from end to end.

In the case supposed the tube is straight; but there is no reason why such a tube should not be measured and fitted to the contour of the bottom, and sunk into its bed by a similar process; the only difference being that the concave of the bow would be already submerged on being floated into position. In the supposed case, also, the force of flotation was intercepted by the adhesion of the floor and sides of the tube to the trench bottom and to the filling-in stuff thrown back from above, as well as counteracted by the weight of the replaced river-bottom. The adhesion, however, due to a perfect contact of so large a surface as the floor of such a tube with a soft river- or sea-bottom would, theoretically, exclude flotation, even though the top and sides of the tube were surrounded by free water. Assuming perfect contact

to exist only in theory, we may easily conceive of arrangements by which the under margins of such a flooring could be made to bite into such a bottom to a sufficient depth to break the continuity of the water pressure from above, as well as to resist the sliding action of currents.

I submit that the Academy might advantageously employ a portion of the fund for aiding Scientific Research in investigating experimentally the force of adhesion under varying heights of water pressure, and defining the point at which the dynamical action of water is arrested by the interposition of non-fluid matter.

Since I put the foregoing Paper into the hands of the Secretary, I have learned—what indeed I might have foreseen to be highly probable—that one leading thought in it has already occurred to other minds. Our brother Academician, Mr. Thomas F. Pigot, Professor of Engineering in the Royal College of Science, informs me that, "When the scheme for the Channel Tunnel was proposed, one of the suggestions was to construct a water-tight metal tube immersed on the bed of the straits"; and that the deposit of an iron syphon of three feet in diameter under a waterway of eighty feet wide, at Dantzig, was effected by excavating a sub-aqueous trench for its reception. I assure the Academy, however, that it was from no desire to seek credit for priority of invention I ventured into this region of speculation, or presumed to invite, as I have done, the attention of our leading Civil Engineers to the subject. The primary motive inducing me has been, I confess, a wish to bring the Engineering intelligence of the country to consider whether a way may not be found for preserving our city from the necessity of a high-level railway bridge over the Liffey. If, in prosecuting this purpose, I have put forward the rudimentary outlines of a method of more general application, by which unbroken traffic might pass from bank to bank of the Suir at Waterford, or of the Rhine at Cologne, without impediment to navigation, and without the necessity of having to seek a rock stratum entailing lengthened approaches, it will not commend itself the less to practical minds because it has originated in a desire that the architectural beauties bequeathed us by that splendid race of men who once inhabited Dublin may be preserved unimpaired for the enjoyment of future generations. I have not been unmindful of the maxim *ne sutor*, and have not presumed to bring my crude conceptions before this assembly without having had the assurance from a competent authority, as regards the tunnel of 400 feet above described, that, subject to some alterations of detail in execution, "the project is one well within the range of practical application."

XI.—Report on the Botany of the Island of Rathlin, County of Antrim. By Samuel A. Stewart, Fellow of the Botanical Society of Edinburgh, Curator of the Collections in the Museum of the Belfast Natural History and Philosophical Society.

[Read, January 14, 1884.]

Rathlin Island is situated at the northern extremity of the Antrim coast, in lat. 55° 20′ north, and 6° 15′ west longitude. It has an area of 3200 acres, and is, consequently, the largest island on the coasts of the North of Ireland. Landing on Rathlin, the visitor finds himself on a belt of rocky, mountainous land, ranging from about half a mile to over one mile in breadth, and extending for a distance of about five miles in a direction which is almost exactly east and west. At the lighthouse, which is located at the extreme north-east, the coast bends at a sharp angle, and runs thence southwards for over three miles, terminating, in this direction, at Rue Point, in Ushet. Fairhead, on the mainland, is separated from the island by nearly four miles of a turbulent sound, through which rapid tidal currents run with immense force, rendering the passage impossible in a high wind. As stormy weather is here of frequent occurrence, the communication with the Antrim coast is often cut off for longer or shorter periods. On the occasion of my third visit, which was in August, there were three days in succession during which the boat could not leave. The main portion of the island lies seven to eight miles off the Antrim coast; while the nearest point in Scotland is the Mull of Cantyre, distant about fourteen miles to the east. Islay is some twenty miles to the north.

The physical aspect of Rathlin is not inviting. No flowing outlines of softly-swelling landscapes meet the eye, but bare, rugged crags, which are neither relieved by sylvan glades nor running water. The rocky foundation has only a very slight covering of soil to absorb excess of moisture; and numerous depressions amongst the crags are filled with water, and form lakelets, which are sometimes of considerable depth. The largest sheet of water is the lake at Ushet, which has an area of over thirty acres. Cleggan Lough, to the north-west, is a deep basin, enclosed in an amphitheatre of low hills. Its area is about ten acres. There are, in addition, many reedy marshes, assuming the aspect of lakes in a wet season, but which, nevertheless, disappear, or become reduced to very small dimensions in dry weather.

The land surface rises steadily from Ushet at the south and east to the Bull at the west end of the island; and as if to compensate for the unprepossessing interior, the western sea-cliffs are magnificent. The rocks on the south side are mainly of hard chalk, precisely similar to

the white limestone cliffs which produce such a picturesque effect at many points on the Antrim coast. At the west and north-west these limestone rocks give way to dark trap, identical with the rocks of the Basaltic Plateau of Antrim. These traps are sometimes massive, but often more or less columnar. At the north-west there are great basaltic cliffs, which rise sheer out of the water to a height of between 300 and 400 feet. These cliffs are frequently composed of huge columns, and, in the early summer, are tenanted by innumerable sea-birds, which find on the many inaccessible ledges a secure retreat in which to place their nests and bring out their young. Land birds are not abundant, Lepidoptera are few in number, and the fauna is in general poor. Hares have been introduced, and are now well established · but it is remarkable that the frog, so common on the mainland, has not yet penetrated to Rathlin. Trees do not grow naturally on the island; and the only wood is a small grove planted near Mr. Gage's residence; and these trees, though well sheltered from the northern winds, are yet by no means in a flourishing condition. This absence of timber has not always been the case, as trunks and branches of trees and numbers of hazel nuts have been dug up in the bogs. The deforesting, if we may so call it, was doubtless caused by scarcity of fuel. There are now no peat bogs on the island; and the greatest want of the people is something to burn. Everything has been cut down long since; and now, when there is nothing to break the force of the storms which career over the surface, it is difficult to induce either tree or shrub to grow.

At the commencement of the present century, the population of Rathlin was about 1200. It is now reduced to one-half of that number, with advantage to those that remain. The Rathliners are not now the simple-minded primitive people described by Dr. Hamilton one hundred years ago, and by Dr. Marshall as late as fifty years since. Irish is spoken by the islanders universally, but there are none who are ignorant of the English tongue, and they seem to use both languages indifferently. Their habits and manners, their dwellings and surroundings, and their ideas, are very much like those of people of the same class on the mainland. With good boats and proper equipments for fishing, no doubt a much larger population could be maintained in comfort.

The flora of Rathlin Island was examined in a more or less cursory manner by the Father of Irish Botany, Mr. John Templeton, and afterwards, in 1836, by Dr. David Moore. The results of these researches have been already published in the "Flora of Ulster," and in the "Contributions towards a Cybele Hibernica." Miss Gage, a lady resident in Rathlin, takes a great interest in its native flora; and her album of drawings contains excellent figures, representing the greater part of the plants that occur on the island. A list of Rathlin plants was prepared by Miss Gage for the Botanical Society of Edinburgh; and an abstract was published in the "Annals and Magazine of Natural History" for the year 1850. Dr. Marshall, whose valuable catalogue

of the birds of Rathlin was published by the Academy in 1837,[1] gave as an addendum a list of the plants observed by himself. This list is meagre; and as Dr. Marshall, though an excellent ornithologist, was not a botanist, it is of no value in any doubtful case. The "Flora Hibernica," of Mackay, contains only one reference to Rathlin. The plants which have been stated to occur on Rathlin, and which I did not see, are appended at the end of this Report.

In the lists which follow there are enumerated 318 Flowering Plants and Higher Cryptogams, 3 species of Characeæ, 80 Musci, and 10 Hepaticæ, all of which were collected or noted by me on the spot. The flora has few plants of much rarity, *Potamogeton pseudo-nitens* being the only one previously unknown in Ireland. On the other hand, a number of plants hitherto credited to Rathlin must be deleted, notably *Eriocaulon septangulare,* which was admitted by some unaccountable mistake; and *Crambe maritima,* which, according to Templeton, grew at Church Bay, is now entirely extinct. A noteworthy feature of the flora is the great preponderance of common plants, and the paucity of rare species. This is doubtless owing to uncongenial conditions of climate, in conjunction with a rocky surface, covered to a great extent with wet, barren moors. This is a characteristic of the Rathlin flora, which is made very apparent by a comparison with the general flora of Ireland. The range, in Ireland, of the plants here enumerated is known with a considerable approach to certainty, and they may be classed as follows:—

Found in each of twelve districts of the Cybele Hibernica,	207	species.
in eleven districts,	25	,,
in ten districts,	22	,,
in nine districts,	23	,,
in eight districts,	11	,,
in seven districts,	6	,,
in six districts,	5	,,
in five districts,	3	,,
in four districts,	3	,,
in two districts,	1	,,
in one district,	1	,,

Continuing the comparison, and classing the plants according to the several types established by Watson, the same result will appear. Watson's "British type," consisting of common plants, generally diffused throughout Britain, is represented in Rathlin by 265 species, an undue proportion.

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[1] "Notes on the Statistics and Natural History of the Island of Rathlin," by James Drummond Marshall, M.D., "Royal Irish Academy Transactions," xvii., part 3, Antiquities (1837).

The next largest of Watson's groups, his "English type," is represented in Rathlin by twenty species, namely:—

Nuphar lutea.
Senebiera coronopus.
Hypericum androsæmum.
H. elodes.
Ulex nanus.
Trifolium minus.
Helosciadum nodiflorum.
Smyrnium olusatrum.
Inula helenium.
Pulicaria dysenterica.
Carduus tenuiflorus.
Convolvulus sepium.
Verbascum thapsus.
Centunculus minimus.
Samolus valerandi.
Ceratophyllum demersum.
Habenaria chlorantha.
Potamogeton lucens.
Sclerochloa loliacea.
Festuca arundinacea.

The "Scottish type" has 9 species:—

Parnassia palustris.
Sagina subulata.
Antennaria dioica.
Orobanche rubra.
Lamium intermedium.
Galeopsis versicolor.
Pinguicula vulgaris.
Empetrum nigrum.
Carex dioica.

Of the "Atlantic type" there are six species:—

Raphanus maritimus.
Lavatera arborea.
Lepigonum rupicola.
Sedum anglicum.
Pinguicula lusitanica.
Scirpus savii.

Of the "Highland type" only four species:—

Sedum rhodiola.
Hieracium iricum.
Hieracium pallidum.
Selaginella selaginoides.

Using these figures for comparison with the flora of Ireland at large, we get the following results:—Relative proportions of the several types in the flora of Ireland and in that of Rathlin, disregarding fractions—

	Irish Flora.	Rathlin Flora.
British type, .	58 per cent.	86 per cent.
English type, .	20 ,,	7 ,,
Scottish type, .	7 ,,	3 ,,
Atlantic type, .	4 ,,	2 ,,
Highland type, .	5 ,,	1 ,,
Germanic and Hibernian types,	3 ,,	0 ,,

Alpine plants are necessarily excluded by reason of the low elevation of the hills. The geographical position equally excludes plants of

the Germanic type; but the broad fact of the marked absence of rare species must, I think, be accounted for by the greater stamina and adaptability of the common forms ensuring their success in the struggle for existence under adverse circumstances.

Having visited Rathlin in spring, early summer, and again in autumn, I claim, with confidence, that the list of phanerogams includes nearly everything indigenous to the island. The list of 80 mosses here given, though doubtless requiring to be extended, may nevertheless be accounted as a substantial estimate of the Bryology of Rathlin, and fairly exhibits the prevailing constituents of the moss-flora. Two of the species—namely, *Sphagnum papillosum* and *Hypnum sendtneri*—are additions to the Irish list; while four others are new records for the North of Ireland. These are—*Trichostomum littorale, Tortula hibernica, Tortula atrovirens,* and *Hypnum speciosum.*

The few *Hepaticæ* which conclude my list are only such as forced themselves on my attention. They have all been previously identified as Irish plants by Dr. Moore and others; but one-half of the species have now, for the first time, been assigned a *habitat* in the North of Ireland.

I have been kindly assisted by several specialists in the identification of the critical forms. Professor Babington obligingly revised the Rubi and several other doubtful plants. The Hieracia were determined by Mr. Backhouse; the Pond weeds by Mr. A. Bennett, of Croydon; and the Characeæ by Messrs. H. & J. Groves. I am also under obligation to Mr. G. A. Holt, of Manchester, who kindly looked over such of my Mosses and Hepaticæ as seemed at all doubtful.

LIST OF SPECIES.

Ranunculaceæ.

Ranunculus trichophyllus (Chaix.)—In a lakelet at the south end of the island; sparingly.
R. hederaceus (Linn.)—Marshy places; not common.
R. flammula (Linn.)—Common in wet places.
R. ficaria (Linn.)—Common.
R. acris (Linn.)—Distributed over the island; but not abundant.
R. repens (Linn.)—Frequent; but not abundant.
R. bulbosus (Linn.)—In great abundance.
Caltha palustris (Linn.)—Common.

Nymphæaceæ.

Nymphæa alba (Linn.)—Rare; it occurs sparingly in a lakelet east of Church Bay.
Nuphar lutea (Sm.)—Abundant in lakelets east of Church Bay.

PAPAVERACEÆ.

Papaver dubium (Linn.)—In cultivated fields; not common. My specimens were not sufficient to determine whether this poppy should be ranked under P. lamottei, or P. lecoqii.

FUMARIACEÆ.

Fumaria muralis (Sond.)—In cultivated fields; not common.
F. officinalis (Linn.)—Borders of fields to the south and east; rare.

CRUCIFERÆ.

Nasturtium officinale (R. Br.)—Frequent.
Cardamine hirsuta (Linn.)—In several places; but not common.
C. pratensis (Linn.)—Common.
Sisymbrium officinale (Scop.)—Frequent on roadsides and waste ground.
S. thalianum (Gaud.)—Sparingly on rocks by the shore near Ushet.
Sinapis arvensis (Linn.)—Cultivated fields.
Cochlearia officinalis (Linn.)—Very plentiful.
Capsella bursa-pastoris (D. C.)—Waste ground; not common.
Senebiera coronopus (Poiret.)—By the shore at Church Bay, and east to Ushet.
Raphanus maritimus (Sm.)—In great profusion in the fields of beans and of potatoes, occupying to a great extent the place of the charlock.

VIOLACEÆ.

Viola sylvatica (Fries.)—Common.
V. tricolor (Linn.); β. arvensis (Murr.)—Cultivated fields; not common.

POLYGALACEÆ.

Polygala vulgaris (Linn.)—Common.
P. vulgaris, β. depressa (Wend.)—Frequent on the heaths.

CARYOPHYLLACEÆ.

Silene maritima (With.)—In great profusion.
Lychnis flos-cuculi (Linn.)—Kenramer; rare.
Sagina procumbens (Linn.)—Everywhere common.
S. maritima (Don.)—Gravelly shore at Church Bay; rare.
S. subulata (Wimm.)—Occurs in many places round the west and north ends of the island, growing on bare horizontal rocks at the summit of the cliffs.
Arenaria serpyllifolia (Linn.)—Rocks at the south-west; rare.
Stellaria media (Vill.)—Fields and waste ground; but not at all abundant.

Stellaria holostea (Linn.)—In several places; but not common.
S. uliginosa (Murr.)—Wet places; frequent.
Cerastium glomeratum (Thuil.)—Rare.
C. triviale (Link.)—Common.
Lepigonum rupicola (Lebel).—Abundant, and very luxuriant on the cliffs all round the island.
Spergula arvensis (Linn.)—Common.
Scleranthus annuus (Linn.)—Borders of fields; not common.
Saponaria officinalis (Linn.)—Occurs in some quantity on the roadside opposite Church Bay; it has, however, no claim to be considered a native.

MALVACEÆ.

Lavatera arborea (Linn.)—On the cliffs, sparingly; said to have been introduced.

HYPERICACEÆ.

Hypericum androsæmum (Linn.)—Shady rocks; rare.
H. tetrapterum (Fries.)—By streams at the west end; rare.
H. pulchrum (Linn.)—Distributed over the island; but not very common.
H. elodes (Linn.)—Abundant in some lakelets (rock basins) near the lighthouse, and to the west.

GERANIACEÆ.

Geranium molle (Linn.)—Roadsides and waste ground; not common.
G. dissectum (Linn.)—Borders of fields; rare.
G. robertianum (Linn.)—Common.

OXALIDACEÆ.

Oxalis acetosella (Linn.)—Common.

LINACEÆ.

Linum catharticum (Linn.)—Abundant.
Radiola millegrana (Sm.)—On the gravelly margin of the north-east side of the large lake at Ushet.

LEGUMINOSÆ.

Ulex europæus (Linn.)—Heaths; but only sparingly. In Mr. Templeton's manuscript "Catalogue of the Native Plants of Ireland," the opinion is expressed that U. europæus "is evidently a naturalized plant, rather too tender for the climate." He states that it was unknown in Rathlin until sown by Mr. Gage in 1794 or 1795.
U. gallii (Planch.)—In great profusion over all the elevated uncultivated land in the island.
Sarothamnus scoparius (Koch.)—Abundant

Trifolium pratense (Linn.)—Common.
T. medium (Huds.)—Roadside near the centre of the island, and in several places thence to Bull Point; very luxuriant.
T. repens (Linn.)—Common.
T. procumbens (Linn.)—Abundant on the elevated pastures to the west and north.
T. minus (Sm.)—Common.
Lotus corniculatus (Linn.)—Abundant.
Anthyllus vulneraria (Linn.)—One of the most abundant plants on the island.
Vicia hirsuta (Koch.)—Borders of fields at the south; rare.
V. cracca (Linn.)—Common.
V. sepium (Linn.)—Common.
Lathyrus pratensis (Linn.)—Frequent.

Rosaceæ.

Prunus communis (Huds.); *a.* spinosa (Linn.)—Sparingly in various parts of the island.
Spiræa ulmaria (Linn.)—Frequent.
Agrimonia eupatoria (Linn.)—On rocks at the north and west.
Alchemilla vulgaris (Linn.)—Not common.
Potentilla anserina (Linn.)—Common.
P. tormentilla (Nesl.)—Everywhere abundant.
Comarum palustre (Linn.)—In marshes; frequent.
Fragaria vesca (Linn.)—Not common.
Rubus discolor (W. and N.)—The commonest bramble on the island.
R. carpinifolius (W. and N.)—Waste ground; not common.
R. corylifolius (Sm.); *a.* sublustris (Lees.)—Waste ground; frequent.
R. corylifolius (Sm.); *γ.* purpureus (Bab.)—Not common.
Geum urbanum (Linn.)—Rare.
Rosa spinosissima (Linn.)—In profusion throughout the island. The variety ciphiana, which has flowers of a beautiful pink colour, is to be found on the road leading to the lighthouse, and also on the roadside to the east of Church Bay.
R. tomentosa (Sm.)—Rare. I only met with this rose in one spot.
R. canina (Linn.)—Occurs in several places, but is not common.
Cratægus oxyacantha (Linn.)—Rare. There are scarcely any hedges in Rathlin, and the hawthorn bushes are not only scarce but stunted.

Lythraceæ.

Peplis portula (Linn.)—In marshy ground west of the lighthouse. Rare.

Onagraceæ.

Epilobium parviflorum (Schreb.)—Rare.
E. montanum (Linn.)—Not common.
E. palustre (Linn.)—In wet places; not common.

Haloragaceæ.

Myriophyllum alterniflorum (D. C.)—In the lakes and drains abundantly.

Hippuris vulgaris (Linn.)—Marshes to the north-west; frequent.

Portulaceæ.

Montia fontana (Linn.)—Abundant; the varieties minor and rivulare are equally common.

Crassulaceæ.

Sedum rhodiola (D. C.)—Very fine on perpendicular cliffs at the north-west.

S. anglicum (Huds.)—Abundant over the island.

S. acre (Linn.)—Abundant on cliffs between Church Bay and Ushet Point.

Saxifragaceæ.

Chrysosplenium oppositifolium (Linn.)—Rare.

Parnassia palustris (Linn.)—On cliffs west of the lighthouse; rare.

Umbelliferæ.

Hydrocotyle vulgaris (Linn.)—Common in marshes.

Helosciadium nodiflorum (Koch.)—Rare.

Ægopodium podagraria (Linn.)—Rare. I only met with this, usually common, species near the residence of Mr. Gage.

Bunium flexuosum (With.)—Plentiful in one field, rare elsewhere.

Œnanthe crocata (Linn.)—Sides of streams and drains; frequent.

Angelica sylvestris (Linn.)—On cliffs by the shore, and in wet rocky places; frequent.

Heracleum sphondylium (Linn.)—Common.

Daucus carota (Linn.)—Everywhere abundant.

Torilis anthriscus (Gaert.)—Common.

Conium maculatum (Linn.)—The hemlock is the most abundant of the Rathlin Umbelliferæ, and seems to entirely replace Anthriscus sylvestris, which I did not see anywhere.

Smyrnium olusatrum (Linn.)—Rocks near Ushet; rare.

Hederaceæ.

Hedera helix (Linn.)—Frequent on the rocks.

Caprifoliaceæ.

Sambucus nigra (Linn.)—Rare, and only about houses; probably not native.

Lonicera periclymenum (Linn.)—Rocks at Kenramer; rare.

Rubiaceæ.

Sherrardia arvensis (Linn.)—Cultivated fields, and on rocks; not common.

Galium aparine (Linn.)—Not common.
G. verum (Linn.)—Abundant.
G. saxatile (Linn.)—Common.
G. palustre (Linn.)—Frequent in wet places.

DIPSACACEÆ.

Scabiosa succisa (Linn.)—Common.

COMPOSITÆ.

Eupatorium cannabinum (Linn.)—Shady rocks; rare.
Tussilago farfara (Linn.)—Not abundant.
Bellis perennis (Linn.)—Common.
Inula helenium (Linn.)—A number of plants of the elecampane occur in the corner of a field by the road leading from the chapel to the lighthouse. It can scarcely, however, be accounted a native.
Pulicaria dysenterica (Gaert.)—In several places; but not plentiful.
Antennaria dioica (Gaert.)—Common on grassy heaths.
Achillea ptarmica (Linn.)—Borders of fields; not common.
A. millefolium (Linn.)—Common.
Matricaria inodora, var. β. salina.—On the sea-cliffs in profusion.
Chrysanthemum segetum (Linn.)—Cultivated fields; common.
Artemisia vulgaris (Linn.)—Abundant on roadsides and waste ground.
Tanacetum vulgare (Linn.)—Roadsides in several places, but always suspiciously near to cottages.
Senecio vulgaris (Linn.)—Common.
S. sylvaticus (Linn.)—Waste ground, Church Bay; rare.
S. jacobæa (Linn.)—Common.
S. aquaticus (Huds.)—Common.
Arctium intermedium (Lange.)—Roadsides and waste ground; common.
Centaurea nigra (Linn.)—Roadsides and borders of fields; common.
Carduus tenuiflorus (Curt.)—Shore at Church Bay; not common.
C. lanceolatus (Linn.)—Common.
C. arvensis (Curt.)—Roadsides; common.
C. palustris (Linn.)—Common.
Lapsana communis (Linn.)—Roadsides and waste ground; not common.
Hypochæris radicata (Linn.)—Rocks and waste ground; common.
Leontodon autumnalis (Linn.)—Common.
Taraxicum officinale (Linn.)—Common.
Sonchus oleraceus (Linn.)—Frequent.
S. asper (Hoff.)—Waste ground; rare.
S. arvensis (Linn.)—Cultivated fields; common.
Crepis virens (Linn.)—Damp places; rare.
Hieracium pilosella (Linn.)—Heaths and dry banks; frequent.
H. iricum (Fries.)—Rather frequent on basaltic rocks at the south-east end.

H. pallidum (Fries.) "Not typical"—J. Backhouse. I found this hawkweed very sparingly on the limestone at the south-west of the island.

Campanulaceæ.

Jasione montana (Linn.)—Rocks; common.
Campanula rotundifolia (Linn.)—On rocks; frequent.

Ericaceæ.

Calluna vulgaris (Salisb.)—Heaths; common.
Erica tetralix (Linn.)—Frequent; but not abundant on the heaths.
E. cinerea (Linn.)—Common.

Gentianaceæ.

Erythræa centaureum (Pers.)—Short pastures; not uncommon.
Gentiana campestris (Linn.)—Mountain pastures at the west end of the island; not common.
Menyanthes trifoliata (Linn.)—Marshes and lakes; common.

Convolvulaceæ.

Convolvulus sepium (Linn.)—Occurs in several places, but is not common. With pink flowers by a stream close to the church.

Boraginaceæ.

Anchusa sempervirens (Linn.)—In several places near cottages, and no doubt introduced.
Lycopsis arvensis (Linn.)—Cultivated fields; frequent.
Myosotis cæspitosa (Schultz.)—Marshes; frequent.
M. arvensis (Lehm.)—Fields; not common.
M. versicolor (Reich.)—Fields and wastes; not common.

Orobanchaceæ.

Orbanche rubra (Sm.)—Very rare; only an occasional plant on the cliffs at the south-west.

Scrophulariaceæ.

Verbascum thapsus (Linn.)—Very rare; a few plants only at one spot on the shore at the south-west.
Scrophularia nodosa (Linn.)—Rare.
Pedicularis palustris (Linn.)—Frequent in marshes.
P. sylvatica (Linn.)—Common.
Rhinanthus crista-galli (Linn.)—Common.
Euphrasia officinalis (Linn.)—Common.
Bartsia odontites (Huds.)—Frequent.
Veronica beccabunga (Linn.)—Beside the streams; common.

V. chamædrys (Linn.)—Common.
V. officinalis (Linn.)—Not common.
V. arvensis (Linn.)—Cultivated fields; not common.
V. agrestis (Linn.)—Fields; not common.

LABIATÆ.

Mentha aquatica (Linn.)—By the streams; frequent.
Thymus serpyllum (Linn.)—Everywhere abundant.
Prunella vulgaris (Linn.)—Not common.
Nepeta glechoma (Benth.)—Rare.
Lamium intermedium (Fries.)—Abundant in cultivated fields.
L. purpureum (Linn.)—Fields and waste ground; not common.
Galeopsis tetrahit (Linn.)—Cultivated fields; frequent.
G. versicolor (Curt.)—Fields; not common.
Stachys sylvatica (Linn.)—Shady rocks at the south-west end; rare.
S. palustris (Linn.)—Fields and damp ground; not common.
S. palustris; β. ambigua (Sm.)—By the shore west of the church; occurring on wet limestone rocks.
S. arvensis (Linn.)—Cultivated fields; plentiful.
Teucrium scorodonia (Linn.)—Frequent on the rocks.
Ajuga reptans (Linn.)—Not common.

LENTIBULAREACEÆ.

Pinguicula vulgaris (Linn.)—Boggy places; common.
P. lusitanica (Linn.).—Plentiful by the boggy margins of lakelets near the lighthouse, and further west.

PRIMULACEÆ.

Primula vulgaris (Linn.)—Common.
Lysimachia nemorum (Linn.)—Frequent.
Glaux maritima (Linn.)—Shore at Church Bay.
Anagallis arvensis (Linn.)—Fields and waste ground; common.
A. tenella (Linn.)—Marshy ground; common.
Centunculus minimus (Linn.)—Very rare; shore of Ushet Lake in small quantity.
Samolus valerandi (Linn.)—Frequent on the margins of lakes at Ushet.

PLUMBAGINACEÆ.

Armeria maritima (Willd.)—Common all round the shores of the island.

PLANTAGINACEÆ.

Plantago coronopus (Linn.)—Abundant over the entire island.
P. maritima (Linn.)—With the preceding; common.
P. major (Linn.)—Roadsides and waste ground; common.

P. lanceolata (Linn.)—Roadsides and fields; common. We have in the Island of Rathlin all the species of plantain which are native in Ireland: I observed the whole four growing on the same road within the space of one hundred yards.
Littorella lacustris (Linn.)—Common on the margins of the lakes.

CHENOPODIACEÆ.

Chenopodium album (Linn.)—Borders of cultivated fields.
Atriplex deltoidea (Bab.)—Sea-shore west of the church; not common. I take this to be the variety salina, of Babington's Manual; it is frequent on the coasts of Down and Antrim.

POLYGONACEÆ.

Rumex obtusifolius (Linn.)—Waste ground; frequent.
R. crispus (Linn.)—Waste ground and roadsides; common.
R. acetosa (Linn.)—Common.
R. acetosella (Linn.)—Common.
Polygonum persicaria (Linn.)—Frequent.
P. hydropiper (Linn.)—Margin of Ushet lake; not common.
P. aviculare (Linn.)—Waste ground about Church Bay; not common.
P. convolvulus (Linn.)—Fields and waste ground; frequent.

EMPETRACEÆ.

Empetrum nigrum (Linn.)—Rocks to the west of the lighthouse; rare.

EUPHORBIACEÆ.

Euphorbia helioscopia (Linn.)—Borders of fields; frequent.
E. peplus (Linn.)—Near the chapel; rare.

CERATOPHYLLACEÆ.

Ceratophyllum demersum (Linn.)—Ushet lake; rare.

CALLITRICHACEÆ.

Callitriche verna (Linn.)—In lakes and drains.

URTICACEÆ.

Urtica urens (Linn.)—Waste ground; Church Bay; rare.
U. dioica (Linn.)—Common.

AMENTIFERÆ.

Salix cinerea (Linn.)—By the large lake at Ushet; rare.
S. aurita (Linn.)—With the preceding species; rare.
S. repens (Linn.)—Abundant over the rocky heaths. There are in Rathlin more forms than one of this willow, but I do not feel confidence in separating them.

CONIFERÆ.

Juniperus nana (Willd)—Rare. A few plants still grow in inaccessible places on the cliffs. Formerly the juniper was plentiful, but it has been nearly exterminated by the practice of wearing it at Easter-time.

ORCHIDACEÆ.

Orchis mascula (Linn.)—Heaths and pastures; frequent.
O. maculata (Linn.)—Meadows and pastures; frequent.
O. incarnata (Linn.)—In marshy ground. The most abundant orchid in the island.
Habenaria chlorantha (Bab.)—Damp mountain pastures; rare.

IRIDACEÆ.

Iris pseud-acorus (Linn.)—Common in wet places.

ALISMACEÆ.

Alisma ranunculoides (Linn.)—Marshes; abundant.
Triglochin palustre (Linn.)—In marshes; common.

LILIACEÆ.

Endymion nutans (Dum.)—In several places; but not common or luxuriant.

MELANTHACEÆ.

Narthecium ossifragum (Huds.)—Frequent in boggy heaths.

JUNCACEÆ.

Juncus effusus (Linn.)—Common.
J. conglomeratus (Linn.)—Frequent.
J. acutiflorus (Ehr.)—Common.
J. lamprocarpus (Ehr.)—Common.
J. supinus (Moench.)—Marshes; Kenramer; frequent.
J. bufonius (Linn.)—Wet places; frequent.
Luzula campestris (Willd.)—Not common.

TYPHACEÆ.

Sparganium ramosum (Huds.)—Marshes at the west side; not common.
S. minimum (Fries.)—In lakelets at the south-east end; rare.

LEMNACEÆ.

Lemna minor (Linn.)—Ditches; not common.

Potamogetonaceæ.

Potamogeton natans (Linn.)—In lakes and ditches; profusely abundant.
P. polygonifolius (Pourr.)—Marshes and drains; common, especially on the elevated plateau at the west end.
P. heterophyllus (Schreb.), var. pseudo-nitens (A. Bennett).—Very rare. I found one specimen only in Ushet lake.
P. prælongus (Wulf.)—Plentiful in the deep water of the large lake at Ushet.
P. perfoliatus (Linn.)—With the preceding; in some quantity.
P. crispus (Linn.)—Ushet lake; rare.
P. pusillus (Linn.)—Lakes at the south end. I found only the variety tenuissimus, which is the common form in the north of Ireland.

Cyperaceæ.

Schœnus nigricans (Linn.)—Wet margins of lakes; rare.
Eleocharis palustris (R. Br.)—Ditches and lakes; common.
Scirpus pauciflorus (Lightf.)—Wet moors at the west end; not common.
S. fluitans (Linn.)—Lakes, ponds, and drains; in profusion everywhere.
S. setaceus (Linn.)—Wet places; rare.
S. savii (S. and M.)—Frequent on boggy ground.
Eriophorum polystachion (Linn.)—Common on boggy ground.
Carex dioica (Linn.)—Kenramer; rare.
C. pulicaris (Linn.)—Frequent.
C. vulpina (Linn.)—Ushet; rare.
C. stellulata (Good.)—Common.
C. vulgaris (Fries.)—Margins of lakes; not common.
C. panicea (Linn.)—Rare and small.
C. pilulifera (Linn.)—Rare and stunted.
C. glauca (Scop.)—Common.
C. flava (Linn.)—Common.
C. hornschuchiana (Hoppe.)—Frequent on the moors.
C. distans (Linn.)—Shore near Ushet; rare.
C. binervis (Sm.)—Kenramer; very rare.
C. hirta (Linn.)—Margin of Ushet lake; rare.
C. ampullacea (Good.)—Lakes and ponds; frequent.

Gramineæ.

Anthoxanthum odoratum (Linn.)—Not common.
Phleum pratense (Linn.)—Not common.
Alopecurus pratensis (Linn.)—Rare.
A geniculatus (Linn.)—Wet places; frequent.
Nardus stricta (Linn.)—Moors; not common.

Phragmites communis (Trin.)—Abundant in the lakes; but I saw no appearance of flowers anywhere.
Agrostis vulgaris (With.)—Not common.
A. alba (Linn.)—Rocks west of the church.
Holcus lanatus (Linn.)—Abundant.
Aira cæspitosa (Linn.)—Frequent.
A. flexuosa (Linn.)—Heaths at the west end; not common.
A. caryophyllea (Linn.)—Frequent.
A. præcox (Linn.)—Frequent at the top of the cliffs.
Avena pubescens (Linn.)—A form of this species which is only slightly hairy is plentiful on the rocks.
Arrhenatherum elatius (M. and K.)—Not common.
Trioda decumbens (Beauv.)—Heaths; frequent.
Kœleria cristata (Pers.)—Rocks, heaths, and pastures; abundant. This grass seems to take the place, to a great extent, of Anthoxanthum odoratum.
Poa annua (Linn.)—Frequent.
P. trivialis (Linn.)—Frequent.
Glyceria fluitans (R. Br.)—Drains and ponds; frequent.
Sclerochloa maritima (Lind.)—On the shore; not common.
S. loliacea (Woods).—Limestone rocks, west of the church; rare.
Cynosurus cristatus (Linn.)—Common.
Dactylis glomerata (Linn.)—Common.
Festuca sciuroides (Roth.)—Limestone rocks west of Church Bay; rare.
F. ovina (Linn.)—Rocks by the shore; not common. The viviparous form occurs on wet heaths at Bull Point.
F. rubra (Linn.)—Common.
F. arundinacea (Schreb.)—Shady rocks; frequent.
F. pratensis (Huds.)—Damp rocky places; not uncommon.
Serrafalcus mollis (Parl.)—Frequent.
Brachypodium sylvaticum (R. & S.)—Rocks by the shore; not common. A form occurs south of Church Bay which has erect spikes, resembling B. pinnatum.
Lolium perenne (Linn.)—Common.

EQUISETACEÆ.

Equisetum sylvaticum (Linn.)—Heaths; rare.
E. limosum (Linn.)—Common in lakes, ponds, and drains. The variety a is the common, if not the only, form in Rathlin.
E. palustre (Linn.)—Frequent, but not abundant.

FILICES.

Polypodium vulgare (Linn.)—Not common.
Lastrea filix-mas (Presl.)—Common.
Athyrium filix-fœmina (Roth.)—Abundant.

Asplenium adiantum-nigrum (Linn.)—Rocks; frequent all round the coast.

A. marinum (Linn.)—Abundant, and luxuriant on the sea cliffs everywhere.

A. ruta-muraria (Linn.)—Very rare. I saw one plant only, on a wall near the chapel.

Scolopendrum vulgare (Sym.)—In a cave east of Church Bay; rare.

Blechnum boreale (Sw.)—Frequent.

Pteris aquilina (Linn.)—Abundant.

Ophioglossum vulgatum (Linn.)—Short pastures on hills above the chapel; rare.

Lycopodiaceæ.

Lycopodium selago (Linn.)—Heaths; rare.

Selaginella spinulosa (A. Br.)—Margins of small rocky lakelets at the north-west; rare.

Characeæ.

Chara fragilis (Desv.)—In several of the lakelets.

Nitella opaca (Ag.)—Frequent in the ponds and lakelets.

N. translucens (Pres.)—Sparingly intermixed with the preceding species.

Musci.

The order of the sequence in the following list is the same as that adopted by the late Dr. David Moore in compiling his "Synopsis of the Mosses of Ireland."

Dicraneæ.

Pleuridium subulatum (Linn.)—Pasture fields; not common.

Dicranella squarrosa (Schrad.)—Rocky banks of stream; rare.

D. cerviculata (Hedw.)—Bogs at the north-west; rare.

D. subulata (Hedw.)—Seen in one spot only, and very sparingly.

Ceratodon purpureus (Linn.)—Waste ground; not common.

Dicranum scoparium (Linn.)—Heaths and rocks; common.

D. majus (Turner)—Shady rocks; not common.

D. bonjeanii (De Not.)—Boggy places; not common.

Campylopus atrovirens (De Not.)—Wet heaths; frequent, but always barren.

C. fragilis (Br. et Schimp.)—Common on the heaths.

Grimmieæ.

Grimmia pulvinata (Dill.)—Rocks and stones; very common.

Schistidium maritimum (Turner.)—Common on the rocks by the shore.

S. confertum (Funck.), var. incanum.—In several places on amygdaloidal rocks.

Glyphomitrium Daviesii (Dicks.)—Basaltic rocks; rare.
Ptychomitrium polyphyllum (Dicks.)—Common.
Racomitrium lanuginosum (Hedw.)—Frequent on the heaths.
R. aciculare (Linn.)—On stones in streams; common.
R. fasciculare (Schrad.)—Rocky heaths.

LEUCOBRYEÆ.

Leucobryum glaucum (Linn.)—Frequent on the heaths.

TRICHOSTOMACEÆ.

Phascum cuspidatum (Schreb.)—Rare, only found in one spot.
Gymnostomum microstomum (Hedw.)—Not common.
Pottia heimii (Dicks.)—Rocky sea-shore; not common.
P. truncatula (Linn.)—Fields; not common.
Weissia viridula (Brid.)—Common.
W. verticillata (Linn.)—On wet, vertical, limestone rocks, in small quantity, and barren.
Didymodon rubellus (B. & S.)—Waste ground; frequent.
Trichostomum mutabile (Bruch.)—Rocks in damp places; rare.
T. tophaceum (Brid.)—Wet rocks; not common.
T. littorale (Mitt.)—On rocks in several places; not known elsewhere in Ireland.
T. crispulum (Bruch.), var. elatum; (Schimp.)—Sparingly on rocks at the west end.
Tortula atrovirens (Sm.)—Very rare, one small tuft only observed.
T. revoluta (Schwg.)—Wall at the demesne; rare.
T. muralis (Linn.)—Walls and rocks; common.
T. fallax (Hedw.)—Damp clay banks; frequent.
T. rigidula (Dicks.)—Damp rocks; not common.
T. subulata (Linn.)—Dry banks; frequent.
T. lævipila (Brid.)—Frequent on the limestone rocks.
T. hibernica (Mitten.)?—This is a barren moss which, when collecting, I took for a form of Didymodon cylindricus. It is not that species; and Mr. Holt, after a careful examination, and with some hesitation, considers it "a poor, drawn form of Tortula hibernica, but decidedly abnormal." It is not rare on the basaltic rocks.

ORTHOTRICHEÆ.

Orthotrichum cupulatum (Hoff.)—Wet rocks; the variety nudum of Dickson.
O. diaphanum (Schrad.)—Sparingly on stones west of the church.
O. phyllanthum (Brid.)—On rocks in several places.
Zygodon stirtoni (Schimp.)—Basaltic rocks; rare.

FUNARIEÆ.

Entosthodon templetoni (Hook.)—Rocks by streams; rare.

Bartramieæ.

Bartramia fontana (Linn.)—Wet, splashy places; common.
B. arcuata (Dicks.)—Damp rocks; common, but barren.

Bryeæ.

Bryum pseudotriquetrum (Hedw.)—On wet rocks in several places.
B. alpinum (Linn.)—Limestone rocks to the west of the church; barren.
B. capillare (Linn.)—Common.
Aulacomnion palustre (Schwaeg.)—Bogs in the north and west.
Mnium hornum (Linn.)—Frequent on shady banks.
M. punctatum (Hedw.)—Wet rocks; rare.

Hypneæ.

I have not availed myself of the recent subdivisions of the genus Hypnum of Dillenius, to which so many able bryologists attach a generic value. However desirable that, for convenience of reference, the species should be grouped by minor characters, yet it seems to me that these groups constitute sections only of a large but very natural genus. The introduction of a burdensome trinomial system has also been avoided.

Homalothecum sericeum (Linn.)—Frequent on damp rocks.
Thamnium alopecurum (Linn.)—Rocky banks of streams.
Thuidium tamariscinum (Hedw.)—Damp mossy banks; not common.
Hypnum undulatum (Linn.)—Heathy places; not common.
H. lutescens (Huds.)—Sparingly on the limestone rocks.
H. populeum (Hedw.)—On rocks; frequent.
H. rutabulum (Linn.)—Common.
H. ruscifolium (Dill.)—On rocks in streams; common.
H. tenellum (Dicks.)—Common on the limestone.
H. striatum (Schreb.)—Damp shady rocks; rare.
H. prælongum (Dill.)—Shady banks; frequent.
H. speciosum (Brid.)—Damp rocks; rare and barren.
H. serpens (Dill.)—Common.
H. cuspidatum (Dill.)—Abundant in marshy ground.
H. purum (Linn.)—Mossy banks; not common.
H. schreberi (Willd.)—Common on the heaths; no fruit.
H. scorpioides (Linn.)—Boggy places in the north-west; quite luxuriant, but always barren.
H. sendtneri (Schimp.)—Boggy ground; rare and barren.
H. filicinum (Linn.)—Wet rocks; frequent.
H. molluscum (Hedw.)—Limestone rocks; frequent.
H. cupressiforme (Dill.)—Common.
H. resupinatum (Wils.)—Frequent.
H. squarrosum (Dill.)—Common.

SKITOPHYLLEÆ.

Fissidens adiantoides (Hedw.)—Frequent on rocks in boggy ground.
F. taxifolius (Linn.)—Banks of streams; frequent.

POLYTRICHEÆ.

Pogonatum aloides (Hedw.)—Common.
Polytrichum juniperinum (Willd.)—Frequent on the heaths.

SPHAGNEÆ.

Sphagnum acutifolium (Ehr.)—Common.
S. papillosum (Lindberg.)—On boggy heaths.

Grimmia leucophea (Grev.); Pleuridium nitidum (Hedw.), and Ephemerum serratum (Schreb), were found on Rathlin by Dr. Moore in 1836.

HEPATICÆ.

As regards the Hepaticæ, I can merely enumerate the species which I collected on Rathlin, as my researches were not sufficient to enable me to give an estimate of their abundance, or otherwise.

Asterella hemispherica (Linn.)
Frullania dilatata (Linn.)—New to flora of the north of Ireland.
F. tamarisci (Micheli.)
F. germana (Taylor).
Lejeunia serpyllifolia (Dickson).
Chiloscyphus polyanthas (Linn.)—New to the northern flora.
Kantia trichomanis (Linn.)—New to the northern counties.
Scapania undulata (Dill.)—New to the north.
Diplophyllum albicans (Linn.)
Jungermannia riparia (Taylor).—New to the north.
Fossombronia pusilla (Linn.)—Found in Rathlin by Dr. David Moore.

[APPENDIX.

APPENDIX.

Species previously recorded as occurring in Rathlin, but not seen there by S. A. Stewart.

Ranunculus sceleratus.

In Dr. Marshall's list; but certainly not now on the island.

Draba verna.

In Miss Gage's list. Possibly the stunted form of Arabis thaliana that grows very sparingly on the south end of the island was mistaken for this. D. verna has been found near the Giant's Causeway, but there is no likely *habitat* in Rathlin.

Draba muralis.

Miss Gage's list. An error; not native in Ireland.

Brassica oleracea.

Among stones on the beach, Church Bay.—Miss Gage. Doubtless escaped from cultivation. The cabbage is occasionally met with in a pseudo-wild state on the sea-shore.

Crambe maritima.

"At Church Bay, Island of Rathlin."—Mr. Templeton. Long since extinct on Rathlin. Mr. Templeton's note on this plant is as follows:—"Gravelly shore at Church Bay in Rathlin Island. Inserted on seeing it in Mr. Gage's garden in Rathlin, who transplanted it from the shore, where it is now destroyed, 1794."—Templeton MSS.

Elatine hexandra.

In Miss Gage's list. A plant likely to occur in the large lake at Ushet, but I did not find it.

Silene armeria.

"Not frequent."—Dr. Marshall's list. A garden escape.

Malva sylvestris.

"On one of the hills on the north shore."—Dr. Marshall's list. This was Lavatera arborea.

Malva rotundifolia.

In Miss Gage's list; also in Flora of Ulster. No doubt correct; but this is a plant that is decreasing in frequency in the north of Ireland. I do not know of its existence now anywhere in county Antrim.

Trifolium arvense.

"On dry places on the sides of hills above Church Bay, Rathlin Island."—Templeton MSS. A plant which could scarcely be mistaken, but must have been in small quantity, as there are but few dry places on the wet, heathy hills above Church Bay.

Lythrum salicaria.

In Miss Gage's list. A plant which I expected, but did not find.

Epilobium hirsutum.

Miss Gage's list, and Flora of Ulster. I suspect this was E. parviflorum.

Sedum reflexum.

In Miss Gage's list. Was S. acre.

Saxifraga hypnoides.

In Miss Gage's list. A plant to be expected, but must be very rare in Rathlin.

Œnanthe fistulosa.

In Miss Gage's list. I fear some error; Œ. fistulosa shuns such cold, rocky, exposed ground as the Rathlin marshes.

Galium pusillum.

Miss Gage's list, and Flora of Ulster. Was G. saxatile; a common error.

Knautia arvensis.

Miss Gage's list, also Flora of Ulster. Has been imported with seed; a frequent casual.

Artemisia maritima.

In Miss Gage's list. Was A. vulgaris.

Carduus crispus.

"Common."—Dr. Marshall. Erroneous identification.

Cuscuta epilinum.

In Miss Gage's list. A casual.

Orobanche major.

In Miss Gage's list. Was O. rubra.

Myosotis palustris.

In Dr. Marshall's list. Was M. cæspitosa.

Veronica scutellata.

Miss Gage's list, also Flora of Ulster. A likely plant; I did not, however, find it.

Ballota fœtida.

Miss Gage's list, and Flora of Ulster. Probably introduced; I did not meet with it anywhere.

Lamium album.

Miss Gage's list, also Flora of Ulster. Not seen by me; an uncertain plant.

Lamium incisum.

Miss Gage's list, also Flora of Ulster. Was likely L. intermedium. The former is very rare in the north of Ireland.

Beta maritima.

Miss Gage's list, and Flora of Ulster. A plant to be expected.

Suæda maritima.

Miss Gage's list. A plant that could hardly be mistaken, but I did not see it; there are few spots in which it could grow.

Malaxis paludosa.

In Miss Gage's list, also Flora of Ulster. Occurs on Fair Head, and might be expected in Rathlin.

Scilla verna.

Miss Gage's list. My search for this was in vain.

Eriocaulon septangulare.

"Abundant."—Miss Gage's list. An unaccountable mistake; the very superficial resemblance of the stems of Eleocharis may have caused the error.

Carex paniculata.

Miss Gage's list, also Flora of Ulster. An error of determination, I believe.

Carex riparia.

Miss Gage's list, and Flora of Ulster. Erroneous.

Lolium temulentum, β. arvense.

"In dry places on hills above Church Bay."—Dr. Marshall's list. Some form of L. perenne.

XII.—REPORT ON IRISH LEPIDOPTERA. By W. F. DeV. KANE, M.A.

[Read, January 28, 1884.]

My researches this summer, chiefly on the south and south-western coast of Ireland, have been attended with some very interesting results in regard to the distribution of species, and may, perhaps, help to elucidate in a small degree the problem as to whence this island originally derived its Lepidoptera.

The migration of this order of insects has not yet been studied as the subject deserves, considering the light it is capable of throwing on the early history of islands and portions of continents, in conjunction with botany and geology.

Mr. Wallace has recorded some remarkable facts observed during his travels in the Malay Archipelago, and some of his conclusions bear upon the subject to which I invite your attention.

The introduction of members of the tribe of Lepidoptera into such an island as this, may be presumed to have taken place in any one of the following ways:—

Firstly (if our geological history permit the supposition), by overland migration, previous to our disruption from the mainland.

Secondly, by flight, either voluntarily in favourable weather, or by a fertile female being blown across the sea by a storm.

Thirdly, by water—ships frequently harbouring insects which have flown on board, and lodged in the folds of sails or other gear, or else by the importation of their ova on some living plant or dried herbage.

I will offer a few remarks on each of these three possible hypotheses.

Those who have not studied the subject will most likely jump to the conclusion that most of our moths and butterflies came hither by flight. Now, Mr. Wallace states that an arm of the sea of far less width than that which separates the Isle of Man from the neighbouring coasts has in many instances in the Malay Archipelago proved an insuperable barrier to a large number of species, even of birds of ordinary powers of flight. He says:—"It may perhaps be thought that birds, which possess the power of flight in so pre-eminent a degree, would not be limited in their range by arms of the sea, and would thus afford few indications of the former union or separation of the islands they inhabit. This, however, is not the case. A very large number of birds appear to be as strictly limited by watery barriers as are quadrupeds." Again—"Insects furnish us with similar facts wherever sufficient data are to be had." In another place Mr. Wallace points out that, although the strait between Bali and Lombock is only fifteen miles wide, yet that the characters of the natural

productions differ so completely that "we may pass in two hours from one great division of the earth to another, differing as essentially in their animal life as Europe does from America." He elsewhere states that neither climatic nor geological conditions account for the phenomena presented.

Entomologists frequently meet with cases somewhat similar. On the hypothesis of an immigration by flight, we should expect to find islands pretty uniformly peopled only with insects powerful on the wing, and of hardy habit. Now, although many such, doubtless, disseminate themselves thus, yet the feebler families of Lepidoptera, to whom this would be an impossibility, are represented on our Irish list in full proportion, as any one who will take the trouble to compare it with that of England will find. And further, also, out of the thirteen British moths which have apterous females, the introduction of which must necessarily have taken place in some other manner, we can reckon ten as indigenous here,—a very remarkable proportion. Of this number I have to announce the addition this year to our list of one very remarkable species of extreme interest, to which I shall again refer, *i.e.* Nyssia zonaria.

Of the whole of the insects of this order, the family of Sphingidæ, by shape and size, is undeniably best fitted of any for migration on the wing. We therefore should expect that every British Sphinx which could find its proper food, and a suitable climate here, would be represented in Ireland. Nevertheless, it is remarkable that S. ligustri, perhaps the hardiest and most commonly distributed species throughout England, is totally absent from this country. As for Acherontia atropos, our largest British moth, I believe that, with the more extended cultivation of the potato on the Continent, it has greatly increased in numbers and distribution, and I have no doubt that it has often crossed the English and Irish Channel; and with regard to this, I have to record the capture of one specimen at the Tuskar Lighthouse, a distance of six miles from the Wexford coast. Messrs. Bates and Wallace, when at anchor off Salinas, South America, six miles from land, saw two large Sphinx moths.

The absence of Deilephila galii and D. euphorbiæ from Ireland is not so strange as their rarity in England with regard to their powers of migration by flight, since both, and especially D. euphorbiæ, are generally fairly abundant on the Continent, and in North France.

How much more remarkable still is the fact that D. lineata (livornica) is a denizen of more than one locality in the west of Ireland, while a specimen of D. celerio was taken a couple of years ago at Mullaghmore, county Sligo, these insects having occurred only a few times in the south of England, and only occasionally in France, except in the extreme south. Mr. Kirby also records the occurrence of a larva of D. celerio in Ireland. The testimony of the Sphingidæ seems, therefore, against any but very occasional immigration by flight even of the swiftest insects.

Join to this the well-known fact that Lepidoptera, both diurnal

and nocturnal, do not fly in an easterly wind, which is the only one which could carry off English specimens perforce across the Irish Sea, and you at once limit the list to those which voluntarily undertake the transit, an impossibility to the Lithosiidæ and Geometridæ, which constitute very nearly two-thirds of our Macro-lepidoptera.

That occasional visitants from France, such as Lycæna bœtica, Papilio podalirius, and Catephia alchymista, have been taken on the south coast of England cannot be denied. But a south, or south-westerly wind, which is one favourable to their activity, would bring them across the Channel. Yet we do not find that the English south coast receives any permanent accessions of species from such arrivals. Many hardy insects, such as Vanessa levana, abound in the north of France, which have never been recorded in Britain.

The genus Dianthœcia is another group of swift-flying insects, though smaller in size than the Sphingidæ. Of this whole genus Great Britain possesses only eight species, four of which have not crossed the Irish Sea; out of which two are scarce and local in the south of England; but of the other two, one is generally common, and the other abundant, in Somersetshire and elsewhere. But Ireland also reckons seven species, three of which are not found in England or Scotland. Of these, the first, D. barrettii, is peculiar to the Hill of Howth, though now considered to be a remarkable variety of D. luteago, a species which occurs rarely in Central Europe.

The second, D. compta, has been taken three or four times in Ireland, and is fairly abundant in France. The third, D. cæsia, an insect found in some mountain districts on the Continent, has been hitherto taken in the Isle of Man, and one specimen at Tramore, by Mr. Warren Wright, many years ago. D. capsophila has been looked on as having its head quarters at Howth, although it is also a Manx insect, and two specimens have been taken at Pembroke, in Wales.

One object I proposed to myself this summer was the further investigation of this group. The occurrence of D. barrettii only in one very restricted locality at Howth, while its food-plant flourishes luxuriantly everywhere on the littoral, seemed a remarkable anomaly. I was successful in taking it on the coast of Waterford, and, I believe, the larvæ on the Wicklow shores, but unfortunately an accident killed the pupæ before they hatched out. I have no doubt that the insect occurs elsewhere, but its habits are such as to render it very difficult to capture. The divergence of this insect from its original type is so great as to lead to the inference that a vast period must have elapsed since its isolation from the parent stock.

D. luteago occurs very rarely in Mecklenburg, Pomerania, and elsewhere in Central Europe, in Sardinia, Corsica, and it is one of the rarest French moths.

The other two Irish species, D. cæsia, and D. capsophila, present a puzzle in their geographical distribution. On the Continent the latter is found in Spain, Corsica, S. France, and Switzerland, but never

abundantly; while D. cæsia frequents the Alpine region of Central Europe, and the Basses Alpes, reaching from Vienna to Piedmont, but is even scarcer than D. capsophila.

D. cæsia has been hitherto looked upon in regard to the British Fauna as a Manx insect—Mr. Wright's capture being of only a single specimen. I am, however, able to announce that Ireland should henceforward be recorded as its head quarters, since I have taken specimens of it in eight localities on the South Coast, reaching from Hook Point to Dursey Island. The Irish and Manx insect is considerably darker than that of Central Europe; but it is not so distinct from the type as is D. barrettii. D. capsophila is also essentially an Irish insect, though twice taken in Wales, and abundant in the Isle of Man. I have traced it in Ireland from Lough Foyle, and Rathlin Island, Howth, Bray Head, and the Wicklow, Waterford, and Cork coasts, to Crookhaven, Berehaven, and Dursey Island in the county Kerry, and in fact it appears abundant wherever its food-plant grows. Mr. Russ has taken it also at Sligo. It is identical with the Continental type, the specimens differing, however, somewhat *inter se*, many from Howth being very grey. The Manx insect, however, does not vary from that taken at Sligo, nor from the majority of the Irish specimens. D. capsophila adapts itself remarkably to the nature of its food-plant, which blooms in succession from mid May to autumn, according to the season and locality; and as the capsules are found in every stage of maturity throughout the summer, so do the larvæ of this insect occur contemporaneously, of all sizes, which is not the case with its congeners, who live on other species of Silene whose season of flowering is more regular. So far for the testimony of strong-winged moths. I turn now to those with wingless females. I have mentioned before that we have ten out of the thirteen English species which possess this remarkable feature.

My friend, Mr. Campbell, of Derry, sent me a drawing of a larva taken at Ballycastle, county Antrim, and some pupæ. I was enabled to identify it as Nyssia zonaria, and he has since forced some of the pupæ and procured the imago. This insect has been hitherto only found in one restricted locality in Great Britain—on the Cheshire coast—though it has a considerable European extension, which, from the peculiarity of its female, seems very remarkable. Frey states it to be widely spread in Switzerland, and it also occurs in France, Germany, Sweden, Russia, Middle and S. Ural, &c. Mr. Birchall, about twenty years ago, let go a number of its larvæ on the sandhills of Malahide, of which, however, I have heard nothing since. But it is not possible that a creature totally incapable of flight, and of unwieldy bulk, could have spread unnoticed to the coast of Antrim within twenty or thirty years.

Another addition of exceeding interest to the Irish list is Deiopeia pulchella, which was taken at Ardmore, on the coast of Waterford, by the son of Richard J. Ussher, Esq., of Cappagh House, in that county. He has kindly consented to present it to the National

Museum, and it will be seen that the small size and pallid coloration of the specimen suggest its having been bred under these sunless skies, and that it is not a waif from some homeward-bound ship. Another specimen has been taken at Bandon by Mr. C. Donovan.

Occasional notices of the capture of D. pulchella are to be found in English journals of Entomology; but even in Central Europe it is exceedingly rare, only sporadic appearances being recorded, except along the Mediterranean littoral, where it is more abundant. Though a delicate and feeble insect, it has a very remarkable geographical range; stretching over Southern Europe and Asia, the N. and S. of Africa, N. America, and Australia; and it has a remarkable persistence of type wherever found.

Now, with regard to the second hypothesis, as to the possibility of this island having been replenished botanically and entomologically by land connexion; most geologists are of opinion that the coast of Antrim was once conterminous with that of the West of Scotland, and that the British Islands were severed from the Continent at a later era than that of the disruption which isolated Ireland.

Such a theory would account for the presence here of Nyssia zonaria, Notodonta bicolora, H. scutosa, and other north and central European forms. The existence of several melanic and other varieties, common both to Scotland and Ireland, seems also, as Mr. Birchall has pointed out, an indication that their fauna (or at least a part of it) have had a common origin; though some allege that similar climatic conditions may sometimes produce similar variations. The objection is not, however, valid as regards racial varieties such as the ones now in question, but applies merely to general characteristics. The Scotch melanic variation of Cymatophora duplaris, however, does not seem to be found in Ireland, those from Cavan and Tyrone, as well as those taken this year in the south, being of the normal English type.

The Irish type of Melitæa artemis, too, as taken by me at Tramore, and Mrs. Battersby, at Cromlyn, in county Westmeath, differs both from the Scotch and English insect.

A very remarkable moth indigenous to Scotland, Acronyctia myricæ, was taken by Mr. Birchall at Killarney. At Galley Head, on a face of bare rock standing amongst the wind-shaven turf, a very novel locality, I detected two pupæ of this species, which must have fed on the dwarf ling which survives here and there in protected spots. Now this moth, though appearing under a different name in the British list, is identical with the strictly Alpine variety of A. euphorbiæ; "Montivaga." To account for the presence here of a variety peculiar to the Central European Alps, whose lowland type pervades the surrounding countries, we are forced to the conclusion that, in company with other hardy species, it once followed the receding ice-cap at the final close of the glacial epoch, northwards, and crossed *viâ* Scotland to Ireland, where with a few botanical species it maintains its evidence as to the Alpine climatic conditions which

once prevailed even in Kerry, whose fiords, with moraines and glacier-planed rocks, bear a like testimony.

But unless Scotland subsequently, yet before its separation from Ireland, enjoyed a very much warmer climate than at present, of which I believe there are no tokens, the heat-loving species, such as Deiopeia pulchella, Deilephila celerio, D. livornica, Lithosia caniola, and Heliothis peltiger, could not have entered by so northern a route. Of this last insect, new to Ireland, I took specimens this summer at Castlehaven and Crookhaven. It is distinctly confined in its range to the south of Europe, Vienna being its extreme northern limit; is not found in Belgium, but occurs in some spots in the south coast of England.

We are thus reminded of the existence of certain Spanish flora in the south and west of Ireland, which would suggest that the soundings between that coast and Brittany may possibly indicate a former connexion with the Continent. But I do not know that there is evidence enough forthcoming to lift the theory out of the region of bare speculation.

I have now discussed shortly two of the three hypotheses, the facts in regard to which seem to point that the greater portion by far of our Lepidopterous fauna must have entered overland, though the presence of south Europæan species offers a difficult problem for solution. And, before passing on, I would like to call attention to what seems to me a very probable and curious illustration of the theory of "survival of the fittest," in conformity to peculiar conditions of life. I find that all except two of the thirteen British moths which, like N. zonaria, have apterous females, although belonging to different genera, have this in common, namely, that their period of emergence and breeding is from October to March inclusive, when high winds prevail; and that they are all tree-feeders, or in the case of N. zonaria, live on the scanty herbage of bare and exposed shores. Being insects of weak flight, the possession of wings by their females would constantly expose them to be blown from their food-plant, so that their larvæ, when hatched, would perish. If this malformation was independent of their breeding habits, it would scarcely, one would think, be confined to the female sex; and if it were a purely generic characteristic, one would expect those species also which have a summer emergence to partake equally of this peculiarity.

However there are two exceptions in the genus Orgyia, namely, the closely-allied forms of O. antiqua and O. gonostigma. The former, however, seems to have adopted very unsettled habits, being polyphagous, and breeding irregularly throughout the summer, from June to the end of October. I therefore consider it, and possibly its relative, O. gonostigma, to have anciently had an October emergence, but subsequently to have adapted itself to changed conditions of climate and food. The occurrence of this deprivation among other orders of insects, too, throws a convergent light upon the subject.

Among the Homoptera three species have been found to possess apterous *males*, one of which is known to live underground. Of the Hymenoptera the ants possess apterous individuals as well as those which deprive themselves of wings; while the Termites among the Neuroptera, and a considerable number of the Coleoptera, chiefly mountain, shore, and marsh-frequenting species, are distinguished by this peculiarity. The restricted nature of their haunts seems to offer some explanation, while the fact that the group of Brachelytra contains a considerable proportion of beetles with habits of flight, is indicative of a different modification of organs in a different direction, considering the impediment which full-sized elytra must offer to a flying insect.

Apologising for the above digression, I shall make a few remarks concerning the possibility of the importation of either the ova or imagos of foreign insects. There is no question that weevils, and species of Blatta and Formica, &c., &c., have thus made their way to this country. But the habits of Lepidoptera (with the exception of some of the micros) do not present equal facilities for their importation. If it were otherwise, then we might expect the shores of the Mersey, of the Clyde, of the Bristol Channel, and of the Thames, to be the richest storehouses for rare species; while, as a fact, the entomologist makes his way to the New Forest, or the fen country in England, or to Rannoch in Scotland, for prizes, where survivors of indigenous species, such as Nonagria sparganii, every now and then reward patient research. The few examples of the introduction of imagos that have occurred from time to time seem only to prove such instances exceptional in the last degree. For instance, at Neath, the splendid North American butterfly, Danais archippus, was taken, a specimen having doubtless been brought over by some vessel entering the Bristol Channel. The ill success, too, which has attended the attempts on the part of naturalists to introduce new species, strengthens the evidence on the negative side.

An eminent London naturalist lately stated to me that of all the instances of transplantation of Lepidoptera into this country that he had heard of, he was not aware of one instance of ultimate success. The transplanted stock rarely take to the locality, but in a season or two disappear. Another of our leading authorities on the subject is of opinion that many insects are, from time to time, introduced in the imago state by ships, but very rarely find a suitable place to settle.

Now, with regard to the importation of ova on dried herbage or living plants, it is very evident that the chances of survival in the former case are extremely small, the larva, when newly hatched, having to crawl in search of its food-plant, most of such insects being narrowly restricted in this respect. Every naturalist who has attempted to rear from ova knows that practically there is no chance of survival. But living plants with ova would present a much more likely medium for the naturalization of new species. The

annual importation of forest trees and others may very well have introduced such species as prefer to live on the foliage of young growth, and are therefore in the habit of choosing such upon which to deposit their ova.

A rare member of the order of Hymenoptera, Lophyrus pini. occurred some years since in considerable numbers among the fir plantations of Lord Powerscourt; and as it in common with others of the Tenthredinidæ, shows a preference for the foliage of young trees, it may very well have become naturalized here in this manner.

The capture last spring of Trachea piniperda by Miss Reynell, at Agher, Co. Meath, is apropos to this subject. Ellopia fasciaria having hitherto been thought to be the only exclusively pine-feeding moth found in Ireland; but T. piniperda has now turned up in Meath, and one specimen in Galway (taken by Lieutenant Walker, of H.M.S. "Hawk").

Now, as there is reason to think that the old woods of Pinus sylvestris were cleared away in Ireland before the country was sufficiently settled to be replanted, the presence of these insects must be explained by either modern importation or (if indigenous survivals), by their having supported themselves upon some other food-plant.

Mr. Barrett has noticed the occurrence of T. piniperda on the Welsh coast, at a very great distance from any of the fir tribe; and Ellopia fasciaria seems to occur in various localities along the Irish coast, and to be very wide-spread. It has been recorded at Sligo and Lough Foyle, and Mr. Sinclair took it at Bray Head; while I can add the localities of Mine Head, Crookhaven, and Glengariff. Evidence as to the survival of specimens of Pinus sylvestris of native Irish race are collected in the "Cybele Hibernica."

The localities I visited are too numerous to offer any list of captures, but the following are notable as having rarities, or by their appearance promising well for the entomologist:—

At Wexford I took Aporophyla australis, recorded already as occurring on the Waterford and Wicklow coasts. The banks of the Slaney above the town look promising.

Tramore, both inland and on the cliffs and sand-hills, which latter are clothed luxuriantly with a very diversified flora, offers many attractions. Agrotis præcox was most abundant in the larval stage, but was decimated by ichneumons.

Mine Head and Queenstown are very productive. The latter place is the first Irish locality that has been recorded for the occurrence of Neuria saponariæ and Bryophila glandifera, v. par. This extremely rare variety has been taken in scanty numbers by Mr. Warren, at Cambridge, and Mr. Stainton is of opinion that it should be named "Impar," as being distinct from the Continental "Par." Near Queenstown it exists in greater abundance than at Cambridge, and occurs (as is the case of the Continental variety) in company with the ordinary type.

As my series is more numerous, and more varied in character than that of Mr. Warren, I append a description:—

This variety differs from the type most distinctively by its blurred delineations, the sharp black lines of B. glandifera being *replaced by ill-defined shadings;* the black spots on the costa, however, being retained as in type. In the lighter specimens the clear ground colour of the type is replaced by a faded yellow or greenish dusty grey, marked with dusky shadings, the black ante-marginal lines being replaced by a pale one, *having a dark external blotch where it touches the inner margin.* The darker specimens have a dark olive-grey ground colour, with darker suffused shadings; especially three blotches external to the pale ante-marginal line, of which *the one resting on the inner margin is always deepest in tone.*

Intermediate between the pallid obsolete form and the melanic one just described there is a series differing in depth of ground colour and shading, *the blotch above described being always the darkest mark on the wing.* All four wings have *a slight black line on outer edge* at the base of the ciliæ. *The thorax of this variety also is more or less dusted with minute specks.*

I am indebted to the courtesy of Mr. Warren for an opportunity of inspecting his Cambridge series, and a description of their characteristics. The above has been written, however, exclusively from my own series.

The neighbourhood of Cappoquin and Lismore should produce a varied list of Lepidoptera; the wooded glens that run down from the Knockmealdown mountains must harbour numerous woodland species. The demesne of Dromana, too, contains considerable portions of ancient forest.

The neighbourhood of Glengariff and of Sneem disappointed me, and I have since learnt that both Lieutenant Walker and Mr. Meek, of London, have formed the same estimate of the neighbourhood of Bantry Bay, though the forests of Killarney once clothed the promontory between it and the Kenmare River. Glengariff, however, seems prolific in Coleoptera, as I took several species of Longicorns, and among them the scarce Strangalia aurulenta.

Crookhaven I found very productive, considering its barren aspect; and I am inclined to think that Long Island and Skull would reward a visit.

Waterville I found a very promising locality both for shore and mountain Lepidoptera. At Cloonaghlin, and another lake above Lake Currane, situated in a wild mountain glen, I noticed a profusion of insect life, but met with no rarities in a day's excursion thither. The Arachnidae, however, attracted my attention by their numbers and variety of species. The Clonee Lakes, between Derreen and Kenmare, should yield some good insects. The mountain slope above the upper one, L. Inchiquin, is clothed with the remains of primeval wood.

I append a list of species that are either recorded for the first time

in Ireland, or are rare; and some notes on the distribution of others, which may prove of interest:—

Deiopeia pulchella.—Ardmore, Co. Waterford, by Mr. Ussher.
„ „ Bandon, Co. Cork, by Mr. C. Donovan.
Heliothis peltiger.—Castlehaven and Crookhaven.
Sesia muscæformis (philanthiformis).—S. Saltee Island, county Wexford.
Nyssia zonaria.—Ballycastle, county Antrim, by Mr. Campbell.
Epunda glauca.—Kilderry, Londonderry; also in Killynon, by Miss Reynell.
Dianthœcia barrettii.—Coast of Waterford.
D. cæsia.—Dunmore, Tramore, Ballycotton Bay, Roche's Point, Mine Head, Castlehaven, Crookhaven, and Dursey Island.
D. capsophila.—Lough Foyle, Rathlin Island, Howth, Bray Head, the coast near Wicklow, Dunmore, Tramore, Ballycotton Bay, Roche's Point, Galley Head, Mine Head, Old Head of Kinsale, Castlehaven, Crookhaven, Castletown-Berehaven, Dursey Island.
D. conspersa.—Rathlin Island.
Neuria saponariæ.—Near Queenstown.
Bryophila glandifera. (v. Par.)—Near Queenstown.
Caradrina morpheus.—Lough Foyle, by Mr. Campbell; islands in Kilkerran Bay, county Galway, by Lieut. Walker, R.N.
Aporophyla australis.—Wexford.
Ellopia fasciaria.—Mine Head, Crookhaven, Glengariff.
Cidaria pyraliata.—Mine Head: and Lough Foyle, by Mr. Campbell.
Pelurga comitata.—Ballycotton Bay, Waterville, Roche's Point.
Luperina cespitis.—Mine Head, Roche's Point.
Acidalia immutata.—Glengariff.
Emmelesia blandiata.—Glengariff.
Miana arcuosa.—Roche's Point.
Cymatophora duplaris.—Roche's Point and Glengariff, identical with the English type.
Larentia salicata.—Kinsale.
Tephrosia biundularia.—Glengariff.
Agrotis præcox.—Very abundant at Tramore, Wexford, Waterville.
Ag. cursoria.—Waterville.
Ag. lucernea.—Dunmore, Mine Head, Crookhaven, Dursey Island, Roche's Point.
Leucania littoralis.—Waterville, abundant.
Melitæa artemis.—Tramore; a distinctly Irish form.
Agrotis lunigera.—Roche's Point.
Hepialus lupulinus.—Roche's Point.
H. velleda, and H. hectus, abundant and widely distributed along the south coast.

Acherontia atropos.—The Tuskar Light-house, off Carnsore Point.

Chærocampa porcellus occurs all along the coast.

On the Keragh Islands, some miles from Hook Point, is a vast mass of Silene maritima, which should be the haunt of numerous Dianthœciæ. Here I took Arctia fuliginosa in great abundance, both the imago, pupa, and full-fed larva, on the ragwort, on the 7th June.

Eupithecia expallidata.—Mine Head.
„ isogrammata.—Glengariff.
„ castigata.—Castletown, &c.
„ virgaureata.—Crookhaven.
„ pumilata.—Glengariff, Valentia, &c.
Pyrausta purpuralis.—Glengariff.
„ ostrinalis.—Glengariff.
Herbula cespitalis.—Glengariff and Crookhaven.

Among the Micro-lepidoptera the following may be worth recording:—

Depressaria pastinacella.—Mine Head.
Sciaphila perterana.—Mine Head.
Bactra furfurana.—Roche's Point.
Euchromia purpurana.—Roche's Point.
Orthotænia antiquana.—Roche's Point.
Sciaphila colquhounana.—Roche's Point (a very local species).
Sericoris littorana.—Tramore.
Scoparia truncicolatis.—Sneem.
Ephippiphora argyrana.—Glengariff.
Lobesia atricapitana.—Roche's Point.

XIII.—On the Directions of Main Lines of Jointing observable in the Rocks about Dublin, and their Relations with adjacent Coast Lines, and with Lines of Faulting and Contact of Geological Formations. (Part II.) By J. P. O'Reilly, C.E., Professor of Mining and Mineralogy, Royal College of Science, Dublin. (Plate I.)

[Read, January 28, 1884.]

In a Paper, read before the Academy in February, 1880,[1] I submitted a series of determinations of directions of jointing observable in the rocks about the Bay of Dublin; and by grouping them as regards direction and relative predominance I was able to show that a predominating direction of jointing, very frequent about Dublin Bay, represents very correctly the direction of the coast line between Carnsore Point and Wicklow Head, the mean value of these observed joints being N. 16° 23′ E. I further added, "as regards the eastern coast of Ireland, it may be fairly advanced that it is represented by directions which correspond to lines of jointing observable, in greater or lesser number, about Dublin Bay, and which are as follows:—

"From	Carnsore Point to Wicklow Head, .	N. 16° 23′ E.
,,	Wicklow Head to Clogher Head, .	,, 9° 27′ W.
,,	Bellagan Point, Carlingford Lough, to John's Point, Dundrum Bay,	,, 48° 30′ E.
,,	Donaghadee to Bruce's Castle, Rathlin Is., ...	,, 29° 11′ W.

"It should be noticed that the direction 48° 30′ E. is almost exactly that of the line of porphyritic rocks so markedly characterising the geology of the county Wexford."

I now proceed to detail a further series of observations of directions of jointing made in the environs of Dublin, and from their summary to draw conclusions as to their relations with the outlines of the country and with the adjacent coast lines:—

[*The directions are all taken from N. magnetic.*]

Sandyford:—

258	Granite rocks, with well-marked jointing, vertical, .	8°–9°	W.
259	,, ,, ,, ,, ,, ,, ,, ,, .	10°–13°	W.
260	Cross jointing, ...	77°	E.

[1] These *Proceedings*, ser. ii., vol. iii., p. 295.

Sandyford—*continued.*

261	Jointing in smooth face of rock mass close to road leading to Harold's Grange, ...	47°–48°	W.
262	,, ,, ,, ,, ,, ,, ,, ,, ,, .	45°–46°	W.
263	,, ,, ,, ,, ,, ,, ,, ,, ,, .	49°–50°	W.
264	Direction of axis of gorge lying due north of Three Rock Mountain summit, ...	8°–10°	E.

Killester Quarry :—

265	Three joints in inclined face of limestone bed near railway bridge, ...	109°	E.
266	Broad ½ in. calcspar joint in same face, ...	51°–52°	W.
267	Calcspar joint in rock further west, ...	32°–33°	E.
268	,, ,, ,, ,, ,, ...	32°	E.
269	Close joint near bridge, ...	15°	E.

Malahide Quarry, near Station :—

270	Joint on east side of line at old signal post, ...	9°	W.
271	Face of joint in quarry on west side of line, nearly vertical, ...	15°–16°	E.
272	Ragged sparry cross joint at end of this, nearly vertical,	90°	W.
273	Plain joint, nearly vertical, ...	Nm. Sm.	
274	Set of parallel joints, well marked, nearly vertical, .	3°–4°	E.
275	,, ,, ,, ,, ,, ,, ,, ,, .	1°	E.
276	,, ,, ,, ,, ,, ,, ,, . ,, .	Nm. Sm.	
277	,, ,, ,, ,, ,, ,, ,, ,, .	3°	E.
278	Face of joint, about 15 yards long, nearly vertical, dip (as in case of all this series) about 85° to E., . .	Nm. Sm.	
279	Very broken and principal joint with ochreous filling, .	4°	E.
	Strike of beds here, . . . Nm. 70°–72° W.		
	,, ,, ,, . . . 68° W.		
	Dip, ... 18° towards N.		
280	Cross joint (dipping N. at about 70°), ...	81°	W.
281	,, (,, ,, ,, 75°), ...	92°	W.
282	Joint dipping E., ...	3°–4°	E.
283	Cross joint evidently principal, but not well defined in extent, ...	86°	W.
284	Cross joint on east side of railway (approximatively), .	68°	W.
285	Cross joint on east side, indistinct, but evidently important, with purple ochre lining, ...	62°–63°	E.
286	Similar joint, about 4 yards N. of last, with altered ochreous mass between, ...	67°–68°	E.
287	Face of joint on east side, broad and long, evidently a continuation of a joint on the west side of railway, .	40°	E.

Malahide Quarry, near Station—*continued.*

288	Cross joint, dipping north at about 65°, ...	86°	E.
289	" " " (6 yards from last), . . .	84°	E.
290	Vertical joint on east side of railway, well defined, .	Nm. Sm.	
291	" " west " " " . . .	8°	W.

St. Douglogh's Limestone Quarry :—

292	On south side, jointing close and frequent, ...	87°	E.
293	" " well marked and vertical, . .	77°–78°	E.
294	" joint vertical, but irregular, broad, and filled with calcspar, ...	40°–41°	E.
295	" " " " " " " " .	60°–61°	E.
296	Sparry joint in middle of quarry, ...	47°	E.

Malahide Strand :—

297	About 230 yards east of Robs Wall, Martello Tower, in limestone beds, dipping north about 20°, four calcspar joints, ...	38°	E.
298	" " " " " " " " .	42° 30′	E.
299	" " " " " " " " .	42°	E.
300	" " " " " " " " .	39°	E.
301	Under road in same beds, ...	31°	E.
302	" " "	32°	E.
303	On flat boss of horizontal beds a set of joints, more or less sparry, ...	27°–28°	E.
304	Cross jointing without spar, ...	6°	W.
305	Set of sparry joints, occurring at close intervals under sustaining wall of road, ...	31°–32°	E.
306	Under old castle, and about 80 yards west of it, well-marked and open joint, ...	40°–41°	E.
307	Under old castle, ...	17°	E.
308	" " " " " " " " .	20°–21°	E.
309	Set of big joints, with Dolomite lining 1½ in. thick at close intervals, and running towards castle, . . .	14°–15°	E.
310	Detached block under castle, apparently part of a joint,	14°	E.
311	Great joint, lined with better spar and calcspar 3 in. thick, with companion joint 5 ft. to west, causing a gap in the strand, evidently a principal one; 40 yards east of old castle, ...	31°–32°	E.
312	Jointing crossing these beds, and running towards old castle; broken and without spar, ...	78°	W.
313	Another joint, a little to the east of this, ...	70°–71°	W.
314	Great open joint, about 100 yards east of castle, . .	41°–42°	E.
315	Set of "gashes," lined with calcspar, and forming a direction, ...	13°–14°	E.
316	Direction of "gashes" about, ...	50°–52°	E.

Malahide Strand—*continued.*

317	15 yards east of this, a set of joints, sparry, and one of them 1½ in. thick, ...	31°–32°	E.
318	Thin joints near these, ...	48°–49°	E.
319	Others, ...	7°–8°	E.
320	Sparry and thick joint, ...	4°–5°	E.
321	Set of five joints, ...	5°–6°	E.
322	Crossed by others at, ...	35°–36°	E.
323	150 to 180 yards south-east of old castle, sparry joint, vertical, 1½ in. thick, very distinct, ...	2°–3°	E.
324	Set of spar and Dolomite joints, 1, 1½, and 2 in. thick at intervals of about 2 ft., ...	7°–8°	E.
325	Set of four sparry joints, 2 to 4 in. thick, well marked,	14°	E.
326	Well-marked sparry but wabbling joint, . . .	42°	E.
327	Set of sparless joints, well-marked, nearly perpendicular to beds, ...	5°–6°	E.
328	Well-marked sparless joint, ...	8°	E.
329	Cross jointing of beds, ...	12°–13°	E.
	Beds of Dolomite coming on here, direction Nm· 92° east, dip to north at 26°, running towards east point of Lambay Is., finely jointed by joints at .	32°	E.
330	Close sparry jointing, crossing Dolomite, and apparently anterior to tilting of beds, ...	23°–24°	E.
331	Jointing with Dolomite lining, and evidently having caused dolomitization of beds where traversing, .	3°–4°	W.
332	Thick beds of Dolomite here, from which road metal being obtained. Dip towards north at 41°.		
333	Thick 8 in. vertical Dolomite joint, traversing same beds, ...	8°	E.
334	Joint in the Dolomite here, ...	27°–28°	E.
335	Portion of a thick, vertical, Dolomite joint, ...	24°–25°	E.
	Anticlinal at this point, apparent direction of axis, . . . { Nm· 61° E.; ,, 63°–64° E.; ,, 60° E. } Mean 61° 30′		
336	Dolomite dyke or horse, bounded on the south side, vertical; the Dolomite highly crystalline, and cleaved into small Rhombohedrons, ...	53°–54°	E.
	Direction of beds of Dolomite on east side of great axis Nm· 30° E.; dip 19° towards S.E.		
337	Very close, irregularly, branched, and well-marked Dolomite jointing, in connexion with great main joint, ...	22°–23°	E.
338	Direction of limestone beds about 50 yards south of great joint, ... Nm· 82°–83° E.		
	Dip to south at . . . . ,, 25°		
339	Traversed by jointing, sparry and "gashed," . . .	23°–24°	E.
340	Jointing in contorted limestone beds under sustaining wall of road, ...	19°	W.
	Synclinal trough here.		

Malahide Strand—*continued.*

341	Set of Dolomite beds, dipping towards north. Direction,	85°	E.
342	Great Dolomite joint, ill-defined, in shaly limestone, .	19°–20°	E.
343	Fault running towards sustaining wall of road, . .	55°	W.
	(Carrickhill Tower just in sight.)		
	Direction of beds N^{m}. 92°–93° E. Dip to north at 27°.		
344	Jointing relatively rare here, but markedly vertical and without spar, ...	16°–17°	E.
	Recurrence of Dolomite beds here.		
345	Dolomite joint, apparently the continuation of preceding one, evidently very extended and important, . .	13°–14°	E.
346	Another very important Dolomite joint, here very marked, ...	33°–34°	E.
347	Extremely well-marked, very continuous and open jointing, largely intervalled, cutting these beds, .	17°–18°	E.
348	Accompanied by a system of "gashes," filled with spar, and running on the west side of it. Main direction, .	52°–53°	E.
349	Crossed by open jointing at	72°–73°	W.
350	Two other parallel "gash" systems—one to the east, with jointing, and the other to the west, without, having a direction, ...	19°	E.
	These two systems of main jointing block out the rocks here into great parallelopideds.		
351	Bedding nearly horizontal here, and Dolomite with marked jointing at, ...	3°–4°	W.
352	Joint with 2 to 3 in. thick Dolomite lining, in horizontal Dolomite shale, ...	1°	W.
	A parallel at 5 yards to west, ...	,,	,,
353	Joint to west of last, 8 in. broad, Dolomitic and irregular,	12°	W.
354	Another joint to west of last, 3 in. broad, Dolomitic and irregular, ...	7°–8°	E.
355	Close under roadway, 2 in. Dolomite joint, looking towards Ireland's Eye, ...	25°–26°	W.
	7 or 8 other joints between this and the road, seemingly parallel, and running towards the nose of Howth.		
356	Great fault here, Dolomitic on both sides, with throw, .	78°–80°	W.
	Beds dipping on north side at about 30°.		
357	On shore side, in connexion with a great joint, . .	56°–57°	W.
358	The Dolomite on the south side, thickly scored by thin spar jointing, at	28°–28°	E.
359	The limestone beds coming in again, a few yards to the south of fault. Joints in it at	96°	E.
360	Great open joint under road, at about	85°	W.
	Here grey, crystalline limestones occur, with "gash" veins, one of which near Dyke gave . . .	4°	W.
361	Crossed by a set of sparry joints, short, and ½ in. thick,	20°	E.
362	Another "gash" vein system, ...	7°–8°	E.

Malahide Strand—*continued.*

363	Crossed by jointing without spar, ...	74°	E.
364	Very extended jointing, forming a "gash" system .	26°–27°	E.
365	Well-marked open jointing, without spar (running towards Howth Church), ...	Nm· Sm·	
366	Three "gash" veins on road side of last-mentioned, .	7°–8°	E.
367	Set of thin spar joints, ...	7°–8°	W.
368	Simple joint cutting these, ...	59°–60°	W.
369	Thin spar joint, very extended, ...	3°	W.
370	Beds nearly horizontal here, the spar joints frequent; simple joint crossing these vertically, ...	64°–65°	E.
371	Set of simple open joints, cutting these beds; well-marked and continuous, ...	7°–8°	E.
372	Well-marked joint, deep, crossing the beds, and dipping south (running towards depression on Lambay Is., .	72°–73°	E.
373	Beds rising here towards south, and traversed by jointing at	14°–15°	W.
374	Also by simple jointing, ... (About 100 yards north of Martello Tower.)	Nm· Sm·	
375	Well-marked fault in these beds.	53°–54°	W.
376	Well-marked 1 in. Dolomite joint, corresponding to direction of depression, ...	29°–30°	E.
377	Dolomite joint near road, 70 to 80 yards north of Tower,	29°	E.
378	Joint forming face of rock, looking towards Tower, .	24°–25°	W.
379	Double joint (fault) under Tower, ...	62°–63°	W.
380	Dolomite mass, looking towards Ireland's Eye, . .	24°–25°	W.

Contact of contorted and nearly vertical shales, with limestone on which the Tower is built.

Direction of it about, . .	Nm·	95°–100°	E.
	,,	80°–85°	W.
Direction of vertically cleaved shales, 40 yards south of Tower, ...	,,	93°	E.
Direction of shale beds, dipping north at about 70°, .	,,	87°–90°	E.
,, ,, ,, ,, .	,,	86°	E.

381	Direction of most southerly outcrop on the "Velvet Strand,"	80°	W.

Donabate Coast:—

382	Joint in boss of Cambrian, 60 yards south of Martello Tower, ...	42°–43°	E.
383	Feldspathic lode or vein, 1 ft. thick, in slate, running towards Lambay Is., ...	57°–68°	W.
384	Same, near the Tower, ...	80°–85°	W.
385	Vertical joint in boss of slate rock, north of Tower, .	65°	E.
386	,, ,, ,, compact greenstone, . .	67°–68°	E.

Donabate Coast—*continued.*

387	"Gash" joint, filled with quartzose matter, in boss of conglomorate, 400 yards north of Tower, . . .	62°–63°	E.
388	Dyke in slate rock, looking towards Dalkey Is., with dip towards north at about 70°, ...	21°	E.
389	"Gash" vein in slate rock, ...	54°–55°	E.
390	Vertical and repeated simple jointing, dipping south at about 70°, and crossing these rocks, ...	26°–27°	E.
391	Well-marked jointing, crossing these rocks, . .	20°	W.
392	,, ,, ,, ,, ,, ,, ,, . .	10 -11°	E.
393	Fault, well-marked, dipping north, and running towards Tower on Ireland's Eye, ...	7°–8°	E.
394	Fault, 12 to 15 yards north of last mentioned, . .	6°–7°	E.
395	Great vertical feldspar joint, crossing the slate rock; 1 ft. thick in places, ...	67°–68°	E.
396	Great fault here, crossing last-mentioned, stopping it, and running towards Ireland's Eye, ...	7°–8°	E.
397	Thin, simple, vertical jointing occurring here, . .	83°–84°	W.
398	Ragged vertical jointing occurring here, ...	83°–84°	W.
399	Great fault here, giving rise to a little inlet looking towards north end of Lambay, ...	87°	W.
400	Fault in cave, with well-marked throw of beds, . .	27°–28°	W.
401	Great vertical, gaping joint (beyond little creek), producing a cave with blow hole; looks towards stack of Ireland's Eye, ...	7°–8°	E.
402	Dyke in banded shales near Tower, ...	45°–46°	E.
403	Great fault at contact of slate rock with banded shales, forming inlet (conglomerate mass), ...	7°–8°	E.
404	Inlet, about 200 yards south-west of Tower, with approximate direction, ...	20°	E.
405	Old shaft, about 100 yards from Tower, apparently on a fault running towards Baldoyle and Sugar-loaf Mountain, Cave with fault running towards Howth,	7°–8	E.
	Carboniferous shales, vertical, strike $N^{m.}$ 52°–53° W.		
	,, ,, ,, ,, ,, ,, ,, 66° W.		
	,, ,, ,, ,, ,, ,, ,, 60° W.		
406	Jointing here sparse and unimportant, ...	8°–9°	E.
407	,, ,, ,, ,, ,, ...	29°–30°	E.
408	Fault with lining, dipping south at about 40°, . .	88°	W.
409	Jointing running towards Martello Tower on Portrane shore, ...	39°–40°	E.
410	Well-marked fault, running to north of Lambay Is., with slight dip to south, ...	53°–54°	W.
411	Well-marked joint, producing a little inlet, . . .	$N^{m.}$ $S^{m.}$	
412	Thin jointing, running towards east side of Howth, .	12°–13°	E.
413	,, ,, ,, ,, ,, ,, ,, ,, .	9°–10°	E.
414	,, ,, ,, ,, ,, ,, ,, ,, .	10°–11°	E.
415	Jointing frequent and vertical, with spar lining in face of Lambay Is., ...	7°–8°	E.

Donabate Coast—*continued.*

416	Fault, with caunting of strata, near Martello Tower, .	4°–5°	W.
417	Direction of strata here, ...	72°–73°	W.
418	The beds here highly pitched (Nm· 60°–70°) and serrated on the edges, by very frequent and close jointing, in a remarkable manner, ...	7°–8°	E.
419	,, ,, ,, ,, ,, ,, ,, ,, .	6°–7°	E.
420	This character continues to show itself in the remarkable successson of beds, which continue round N. to the conglomerates, forming the entrance to Rush Harbour, which evidently corresponds to a line of jointing, .	75°–76°	W.
421	On the north side of the harbour the limestone lies flat, or at low angles, and presents sparry jointing at .	53°–54°	E.
	[At the northern extremity of Rush Strand, the strata nearly vertical, with chert cores (Dip to N. at 80°). Direction Nm· 80° E.]		
422	Fault cutting the shales here with slickenside, . .	23°–24°	W.
423	,, ,, ,, chert beds, ...	25°–26°	E.
424	Fault crossing these, ...	75°–76°	E.
425	A spary joint crossing these, ...	27°–28°	W.
426	A set of highly-contorted beds here undergoing marked decomposition, apparently from oxydation of iron pyrites; evidently in some way connected with the stream which comes in here, and which presents two directions, one	28°–30°	W.
427	And another, giving rise to a well-marked ravine, .	73°–74°	W.
	Direction of beds under Giant's Hill, Nm· 88°–90° E.		
428	Two or three sparry joints crossing these at the north-east extremity of little bay or inlet, ...	25°–26°	W.
429	Thick jointing, repeated, crossing north-east end of bay, in direction of Rush point, ...	2°–3°	E.
430	Direction of beds here (quite vertical), ...	75°–76°	W.
	Here Brook's Inlet intervenes with synclinal trough, on the north side of inlet beds dip to south at 40°–45°.		
431	Heavy jointing traversing Drumanagh promontory, .	6°–7°	E.
	On the western shore of the Inlet (Roaring Well Inlet) the chert beds are decomposed as at north end of Rush Strand, with strong indications of manganese and purple ochre.		
432	Mass of Dolomite on south-east side of Drumanagh promontory, looking towards Lambay Island, . .	26°–27°	W.
433	The beds south of the Martello Tower, dipping south at 35°–40°. Jointing in these beds, ...	34°–35°	W.
434	Great fault under Martello Tower, 3 ft. thick in places, being a conglomerate of limestone boulders, cemented by calcspar, ...	33°–34°	W.
,,	Parallel companion joints close to this, some of them strongly marked, ...	,,	,,
435	Crossed by vertical jointing, ...	55°–56°	E.
436	Repeated jointing on north side of fault, . . .	32°–33°	W.

Donabate Coast—*continued.*

437	Frequent and close jointing on south side of Lough Shinney,	2°–3°	E.
438	North-east end of Lough Shinney, fault with filling of boulder conglomerate, badly-defined,	52°–53°	W.
439	Another joint to west of last-mentioned,	28°–29°	W.
440	Farther north, near limekiln,	28°	W.
	Bed of Dolomite corresponding to a saddle-back, about 150 yards north of limekiln and approximate axis, Nm. 55°–56° W.		
441	Cross jointing,	32°–33°	E.
442	Occurrence here of frequent jointing,	10°–11°	E.
443	Joint in connexion with slate clay boulders and conglomerate beds,	8°–9°	E.
	(The boulders apparently of Silurian or Cambrian formation.)		
444	Great open joint, accompanying this, and repeated,	18°–19°	E.
445	Jointing repeated and Dolomitized,	24°–25°	E.
446	,, ,, ,, ,, ,,	27°	E.
447	,, ,, ,, ,, ,,	31°–32°	E.
448	,, ,, ,, ,, ,,	13°–14°	E.
449	Crossed by a well-marked fault,	47°–48°	W.
450	Frequent jointing here (200 yards south of old house),	24°–25°	E.
451	Very long open joint here,	13°–14°	E.
452	Jointing thin, with Dolomite filling,	56°	W.
	(About 100 yards south of old house.)		
453	Cave or open joint, with conglomerate filling, in lower part undergoing decomposition (an old level apparently), the rock outside cave very much jointed,	54°–55°	W.
454	Cross jointing,	27°–28°	E.
455	Near old house,	34°–35°	E.
456	At old house,	29°–30°	W.
457 458	Clay-slate conglomerate beds come in here, with jointing, well-marked, cutting these, and running towards Shenick's Island,	14°–15° 14°–15°	W. E.
459	Another set of joints here,	8°–9°	W.
460	,, ,, ,, ,,	6°–7°	W.
461	Beds of Dolomite, dipping north by east, and traversed by Dolomite joints (about 1 mile from Skerries,	20°–21°	E.
462	Joints in beds under Dolomite,	34°–35°	E.
463	,, limestones, ¾ mile south of Skerries,	5°–6°	E.
464	,, ,, ½ ,, ,,	34°–35°	E.
465	,, ,, ,, frequent,	2°–3°	E.
466	,, ,, ,, ,, ,,	28°–29°	E.
467	,, ,, well-marked and vertical,	26°–27°	E.
468	,, ,, ,, and repeated,	31°	E.

Donabate Coast—*continued.*

469	Long joint, somewhat wabbled in limestone, with Dolomite lining, ...	50°	W.
470	Frequent jointing, crossing beds ¼ mile from town, opposite Shenick's Island, ...	60°	E.

Dodder River, near Donnybrook:—

	[Direction of beds in river, about 100 yards to south of foot-bridge, Nm· 64°–66° E. Dip to east at 60°–70°.]		
471	Frequent jointing, crossing these beds just below the weir, vertical, or only slightly inclined, . . .	42°–43°	E.
472	Frequent and nearly vertical jointing, crossing bed of river, ...	66°–67°	W.
473	The beds at weir dipping towards south-east at about 20°. The fall in the bed of the river produced by a series of joints or faults running, ...	50°	E.
474	,, ,, ,, ,, ,, ,, ,, ,, .	56°–57°	E.
475	,, ,, ,, ,, ,, ,, ,, ,, .	56°	E.
476	Crossed by jointing at	78°	W.
478	,, ,, ,, ,, ,, ,, ,, ,, .	78°–79°	W.
479	Above pond at Clonsilla Bridge, in flat beds of river, .	37°–38°	E.
480	Under wall of old quarry, ...	22°–23°	W.
481	,, ,, ,, ,, ...	7°–8°	W.
482	,, ,, ,, ,, ...	16°–17°	W.
483	Calcspar joint, crossing river bed, ...	30°–31°	E.
484	,, ,, ,, ,, ,, ...	32°	E.
485	Dolomite joint in bed of river, about 50 yards north of old Milltown Bridge, ...	30° 30′	E.
486	Do., do., 1 in. and 2 in. thick joints, frequent and close; 15 to 20 observable in the river bed, . . .	31°–32°	E.
487	Jointing without spar, and jagged, ...	53°–54°	E.
488	,, well-marked, extended, and frequent in bed of river under old Milltown Bridge, . . .	32°	E.

Worthington Quarry, Gollarstown Bridge, Grand Canal:—

489	{ Great calcspar lode, 9 in. thick, cutting beds, . .	} 51°–52°	E.
490	Direction of beds, Nm· 54°–55° W.	52°–53°	E.
	Dip to south-west about 20° . . . . . . }		
491	Crossed by thin jointing, ...	5°	E.
492	,, ,, ,, ,, ...	25°–27°	W.
493	,, ,, ,, ,, ...	28°–29°	W.
494	,, ,, ,, ,, ...	4°–5°	W.
495	Joint in old quarry (Meade's), ...	51°–52°	W.
496	Face of jointing, well-marked, ...	2°–3°	E.
497	Cross jointing on south side, ...	78°–79°	W.

Raheny Quarry:—

498	Face of joint irregular, about	92°	E.
499	Face of joint near south side,	7°–8°	E.
500	Joint on south side,	43°–44°	E.

Palmerston—Quarries of the Asylum:—

501	Beds dipping south at about	15°	
502	Face of jointing,	34°–35°	W.
503	Well-marked face,	38°	W.
504	Crossed by jointing at	26°–27°	E
505	Jointing having probably given rise to bank of river,	88°	W.
506	Another joint,	38°	W.
507	,, ,,	37°	W.
508	,, ,,	87°–88°	W.
509	Jointing close and frequent, cutting beds near house,	41°–42°	E.
510	Jointing crossing this,	41°	W.
511	,, ,, ,,	40°	W.
512	,, ,, ,,	40°	W.
513	Crossed by jointing at	51°–52°	E.
514	And jointing at	41°–42°	W.
515	Sparry face of jointing, [Direction of trough of valley of Liffey as seen from house terrace, N$^{m\cdot}$ 46° 47° W.]	51°–52°	E.

Lucan—Spa in Vesey Demesne:—

516	Jointing on path south of Spa,	7°–8°	E.
517	Crossed by jointing at	88°–89°	E.
518	Face representing jointing, having given direction to river here,	31°–32°	W.
519	,, ,, ,, ,, ,, ,, ,, ,,	28°–29°	W.
520	At weir in the park, edge of beds forming bank of river; a joint face,	2°–3°	W.
521	Crossed by repeated jointing at	53°–54°	W.

Lucan—Vesey Demesne:—

Direction of beds on road through demesne, near Leixlip Bridge, about. Dip to west at about 60°.	30°	E.
Old quarry on north side of river, beds very contorted. Direction of folds on west side of quarry,	53°–54°	E.
	27°–28°	E.
	27°	E.
Beds at Anna Liffey Mills, Dip towards river.	44°–45°	W.

Woodlands:—

522	Face of rock on left of path from gate house, (Continues along the side of stream northwards.)	32°–33°	E.
523	Lead mine, opened on a joint,	20°	E.
524	,, joint crossing this	8°	E.

Woodlands—*continued.*

525	Cross jointing, ...	55°	W.
526	Large joint in rocks, near Hermitage, ...	57°–58°	W.
527	Great face of rock, near gate house, on east side, . . (The bedding dipping slightly towards north at a low angle. The shaft for lead sunk to 130 feet from surface, a level driven 150 feet long on main joint. Black iron pyrites shales at bottom. The rock highly loaded with crystalline quartz.)	17°–18°	E.
528	Between the two shafts nearest river, the direction, .	55°–56°	E.

Rathgar Quarry:—

529	Face of jointing frequent on east side under main roadway, ...	32°–33°	E.
530	Jointing frequent and close in mass of rock, supporting the engine and pumps, ...	43°–45°	E.
531	,, ,, ,, ,, ,, ,, ,, ,, .	33°–34°	E.
532	On north side of quarry, jointing forming face here, .	68°–70°	E.
533	Thick sparry jointing, cutting south side vertically, .	32°–33°	E.

Leixlip:—

	Direction of bed in river, near bridge, . 45°–46° E. Dip to west at about 30°.		
534	Jointing in quarry, east of Salmon Leap, ...	37°	E.
535	,, ,, ,, ,, ,, ,, ,, ,, .	30°–33°	E.
	Direction of beds in this quarry, . . 42°–43° E. Dip about 30° towards river bed.		
536	Near the Leap, face of joint forming margin of river (well-marked), ...	14°–15°	E.
537	,, ,, ,, ,, ,, ,, ,, ,, .	16°–17°	E.
538	Jointing in beds within 50 yards of Leap (sparry), .	52°–53°	W.
539	,, ,, ,, ,, ,, ,, ,, ,, .	53°–54°	W.
540	Crossed by rugged sparry jointing, ... (Seamed or "gash" jointing in the beds here.)	17°–18°	E.
541	Cross jointing, ...	2°–3°	E.
542	Jointing, not sparry, ...	55°	E.
543	Jointing in quarry outside town, on road to Maynooth, .	25°–26	W.

Feltrim Quarry, near Malahide:—

544	Jointing near road, ...	47°–48°	E.
545	,, ,, ,, ...	28°–29°	W.
546	Vertical joint in quarry, well marked and showing copper ore, ...	38°–39°	E.
547 548	Great rough face in old part of quarry, to the east, evidently representing a main joint system, the face broken and scarred by jointing, ...	89° 92°–93°	W. W.
549	Great joint, filled with brown clay, and associated with a system of parallel and close joints; vertical, . .	43°–44°	E.

Feltrim Quarry, near Malahide—*continued.*

550	Crossed by a clay joint, vertical and marked, . .	92°	W.
	[Connected with this jointing is found a mass of black crystalline Dolomite, well marked.]		
551	Joint cutting the face of the quarry, and marked by presence of Malachite and Cuprite, ...	41°–42°	E.
552	Joint further to west, also bearing copper ore, and forming a Dolomite mass, ...	43°–44°	E.
553	Joint further west, ...	2°–3°	E.
554	,, ,, ,, ...	40°–45°	E.
555	,, ,, ,, ...	58°	E.
556	,, ,, ,, ...	48°	W.
557	West side of quarry, frequent jointing; one giving .	46°–47°	E.
558	Face of joint, with brown earthy filling, . . .	47°–48°	W.

Kimmage Quarry:—

559	Sparry jointing under wall of road, ...	39°–40°	E.
560	Frequent ,, ,, ,, ,, ...	40°	E.
561	Dolomite face, evidently part of a main joint, . .	41°–42°	E.
562	On west side of quarry a well-marked Dolomite jointing with Dolomite mass on either side, vertical and repeated, ...	42°–43°	E.
563	Crossed by jointing, ...	56°	W.
	Direction of beds, N^m· 64°–65° W. Dip to south at about 12°		

Crumlin Sand Quarry:—

564	Direction of rib in face of quarry, on west side, . .	68°–70°	W.

Cork—Quarry to East of Queen's College:—

565	St. Gall Abbey laneway, on east side; face of joint .	12°–13°	E.
566	,, ,, ,, ,, ,, ,, ,, ,, .	18°–19°	E.
567	On west side of laneway, face of joint, ...	8°	E.
568	,, ,, ,, ,, ,, ,, ...	11°–12°	E.
569	,, ,, ,, ,, ,, ,, ...	13°	E.
570	Large face of joint at top of lane, ...	12°	E.
571	,, ,, ,, ,, ,, on east side, . .	13°	E.
572	In quarry-hole, St. Gall Abbey, N^m· 83° W., . .	97°	E.
573	,, ,, ,, ,, ,, ,, ,, . .	8°–9°	E.
574	Large quarry to east, great open joint, ...	13°–14°	E.
575	Well-marked joint, partly open, ...	22°	E.
576	,, ,, ,, ,, ,, ...	12°	E.
577	On east side in old quarry, well-marked set of joints, to	12°–13°	E.
578	east of projecting mass of brownish Dolomite, . .	10°–15°	E.

Classifying these directions, and separating them into east and west magnetic directions, the following results are obtained:—

No. of Jointing	Magnetic Bearing.		LOCALITY OF OCCURRENCE	OBSERVATIONS.
273	Nm.	Sm.	Malahide Station Quarry.	The magnetic variation for Dublin, 1883, is taken at W. 21° 20′, as deduced from Admiralty Chart.
274	3° 30′	E.	,, ,, ,,	
275	1°	E.	,, ,, ,,	
276	Nm.	Sm.	,, ,, ,,	
277	3°	E.	,, ,, ,,	
278	Nm.	Sm.	,, ,, ,,	
279	4°	E.	,, ,, ,,	
282	3° 30′	E.	,, ,, ,,	
287	4°	E.	,, ,, ,,	
290	Nm.	Sm.	,, ,, ,,	
323	2° 30′	E.	,, Shore.	
365	Nm.	Sm.	,, ,,	
374	Nm.	Sm.	,, ,,	
411	Nm.	Sm.	Donabate Coast.	
429	2° 30′	E.	,,	
437	2° 30′	E.	,,	
465	2° 30′	E.	,,	
496	2° 30′	E.	Worthington Quarry.	
541	2° 30′	E.	Leixlip.	
553	2° 30′	E.	Feltrim Quarry.	

Number of Directions observed, 20.

36° 30′ ÷ 20 = 2° 4′ mean value. True bearing, 19° 16′ W.

264	9°	E.	Malahide.	
219	7° 30′	E.	,,	Frequent.
320	4° 30′	E.	,,	,,
321	5° 30′	E.	,,	Five joints.
324	7° 30′	E.	,,	Frequent.
327	5° 30′	E.	,,	,,
328	8°	E.	,,	—
333	8°	E.	,,	—
354	7° 30′	E.	,,	—
362	7° 30′	E.	,,	—
366	7° 30′	E.	,,	—
371	7° 30′	E.	,,	—
392	10° 30′	E.	,,	—
393	7° 30′	E.	Donabate Coast.	—
394	6° 30′	E.	,,	—
396	7° 30′	E.	,,	—
401	7° 30′	E.	,,	—
403	7° 30′	E.	,,	—
405	7° 30′	E.	,,	—
406	8° 30′	E.	,,	—
402	12° 30′	E.	,,	—
413	9° 30′	E.	,,	—
414	10° 30′	E.	,,	Frequent.
416	7° 30′	E.	,,	
418	7° 30′	E.	,,	Very frequent; so frequent as to be practically countless.

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
419	6° 30′	E.	Donabate Coast.	—
431	6° 30′	E.	,,	—
442	10° 30′	E.	,,	—
443	8° 30′	E.	Lough Shinney Coast.	—
463	5°	E.	,, ,, ,,	—
491	5°	E.	Gollerstown Bridge Quarry.	—
499	7° 30′	E.	Raheny Quarry.	—
516	7° 30′	E.	Lucan.	—
524	8°	E.	Woodlands.	—

Number of Directions observed, 34.

257° ÷ 34 = 7° 33′ mean value. True bearing, 13° 47′ W.

545	12° 30′	E.	Cork College Quarries.	Note.—These directions are really parallel to those observed about Dublin since—
567	8°	E.	,, ,,	Diff. of Long., ... 2° 18′
568	10° 30′	E.	,, ,,	Excess of magnetic variation over that at Dublin, 2° 28′
569	13°	E.	,, ,,	Total Difference, . 4° 45′
570	12°	E.	,, ,,	This added to mean direction for Dublin, ... 7° 33′
571	13°	E.	,, ,,	Gives for Cork, . . 12° 18′
573	8° 30′	E.	,, ,,	
574	13° 30′	E.	,, ,,	
576	12°	E.	,, ,,	
577	12° 30′	E.	,, ,,	
578	12° 30′	E.	,, ,,	Set of joints.

Number of Directions observed, 11.

129° ÷ 11 = 11° 43′ E. True bearing, 12° 5′ W.

269	15°	E.	Killester Quarry.	—
271	15° 30′	E.	Malahide.	—
309	14° 30′	E.	,,	Set of joints.
310	14°	E.	,,	—
315	13° 30′	E.	,,	Set of joints.
325	14°	E.	,,	Set of four joints.
329	12° 30′	E.	,,	—
344	16° 30′	E.	,,	—
345	13° 30′	E.	,,	—
448	13° 30′	E.	Lough Shinney Shore.	Frequent.
451	13° 30′	E.	,, ,, ,,	—
458	14° 30′	E.	,, ,, ,,	—
536	14° 30′	E.	Leixlip.	—
537	16° 30′	E.	,,	—

Number of Directions observed, 14.

201° 30′ ÷ 14 = 14° 23′ E. mean value. True bearing, 6° 57′ W.

342	19° 30′	E.	—	—
347	17° 30′	E.	—	—
350	19°	E.	—	—
388	21°	E.	—	—
404	20°	E.	—	—
444	18° 30′	E.	—	—

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
461	20° 30′	E.	—	—
525	20°	E.	—	—
527	17° 30′	E.	—	—
540	17° 30′	E.	—	—

Number of Directions observed, 10.

191° ÷ 10 = 19° 6′ E. mean value. True bearing, 1° 14′ W.

308	20° 30′	E.	Malahide Coast.	—
361	20°	E.	" "	—
388	21°	E.	Donabate Coast.	—
404	20°	E.	" "	—
461	20° 30′	E.	Skerries Coast.	—

Number of Directions observed, 5.

102° ÷ 5 = 20° 24′ E. mean value. True bearing, 0° 56′ W.

331	23° 30′	E.	Malahide Shore.	—
335	24° 30′	E.	" "	—
338	22° 30′	E.	" "	—
339	23° 30′	E.	" "	—
423	25° 30′	E.	Rush Coast.	—
445	24° 30′	E.	Lough Shinney Coast.	—
450	24° 30′	E.	" " "	—

Number of Directions observed, 7.

168° 30′ ÷ 7 = 24° ·04′ mean value. True bearing, 3° 44′ E.

291	40° 30′	E.	St. Dolough's Quarry.	—
297	38°	E.	Malahide Shore.	—
298	42° 30′	E.	" "	—
299	42°	E.	" "	—
300	39°	E.	" "	—
306	40° 30′	E.	" "	—
314	41° 30′	E.	" "	—
326	42°	E.	" "	—
382	42° 30′	E.	Donabate Coast.	—
409	39° 30′	E.	" "	—
471	42° 30′	E.	Donnybrook, Dodder River.	—
479	37° 30′	E.	" " "	—
500	43° 30′	E.	Raheny Quarry.	—
509	41° 30′	E.	Palmerstown.	—
530	44°	E.	Rathgar Quarry.	—
534	37°	E.	Leixlip.	—
545	38° 30′	E.	Feltrim Quarry.	—
549	43° 30′	E.	" "	—
551	41° 30′	E.	" "	—
552	43° 30′	E.	" "	—
554	42° 30′	E.	" "	—

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
559	39° 30′	E.	Kimmage Quarry.	—
560	40°	E.	,, ,,	—
561	41° 30′	E.	,, ,,	—
562	42° 30′	E.	,, ,,	—

Number of Directions observed, 25.

1025° ÷ 25 = 41° mean value. True bearing, 19° 40′ E.

296	47°	E.	St. Dolough's Quarry.	—
402	45° 30′	E.	Donabate Coast.	—
544	47° 30′	E.	Feltrim Quarry.	—
557	46° 30′	E.	,, ,,	—

Number of Directions observed, 4.

186° 30′ ÷ 4 = 46° 37′ E. mean value. True bearing, 25° 17′ E.

316	51°	E.	Malahide Coast.	—
318	48° 30′	E.	,, ,,	—
337	53° 30′	E.	,, ,,	—
348	52° 30′	E.	,, ,,	—
389	54° 30′	E.	Donabate Coast.	—
421	53° 30′	E.	,, ,,	—
473	50°	E.	,, ,,	—
489	53° 30′	E.	Gollarstown Bridge.	—
490	52° 30′	E.	,, ,,	—
513	51° 30′	E.	Palmerstown.	—
515	51° 30′	E.	,,	—

Number of Directions observed, 11.

572° 30 ÷ 11 = 52° ·02′ mean value. True bearing, 30° 42′ E.

303	27° 30′	E.	Malahide Coast.	—
334	27° 30′	E.	,, ,,	—
358	27° 30′	E.	,, ,,	—
364	26° 30′	E.	,, ,,	—
376	29° 30′	E.	,, ,,	—
377	29° 30′	E.	,, ,,	—
390	26° 30′	E.	Donabate Coast.	—
407	29° 30′	E.	,, ,,	—
446	27°	E.	Skerries Coast.	—
454	27° 30′	E.	,, ,,	—
466	28° 30′	E.	,, ,,	—
467	26° 30′	E.	,, ,,	—
504	26° 30′	E.	Palmerstown.	—

Number of Directions observed, 13.

359° 30′ ÷ 13 = 27° 39′ E. mean value. True bearing, 6° 19′ E.

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
267	32° 30′	E.	Killester Quarry.	—
268	32°	E.	,, ,,	—
301	31°	E.	Malahide Coast.	—
302	32°	E.	,, ,,	—
305	31° 30′	E.	,, ,,	—
311	31° 30′	E.	,, ,,	—
317	31° 30′	E.	,, ,,	—
330	32°	E.	,, ,,	—
346	33° 30′	E.	,, ,,	—
441	32° 30′	E.	Drumanagh Coast.	—
447	31° 30′	E.	,, ,,	—
468	31°	E.	,, ,,	—
483	30° 30′	E.	Donnybrook, Dodder River.	—
484	32°	E.	,, ,, ,,	—
485	31° 30′	E.	,, ,, ,,	—
486	31° 30′	E.	,, ,, ,,	About 17 joints here.
488	32°	E.	Old Milltown Bridge.	—
522	32°	E.	Woodlands.	—
529	32° 30′	E.	Rathgar Quarry.	—
531	33° 30′	E.	,, ,,	—
533	32° 30′	E.	,, ,,	—
535	31° 30′	E.	Leixlip.	—
455	34° 30′	E.	Skerries Coast.	—
462	34° 30′	E.	,, ,,	—
464	34° 30′	E.	,, ,,	—
322	35° 30′	E.	Malahide Coast.	—

Number of Directions observed, 26.

$841° \div 26 = 31° \, 58'$ E. mean value. True bearing, 10° 38′ E.

435	55° 30′	E.	Drumanagh Promontory.	—
474	56° 30′	E.	Donnybrook, Dodder River.	—
475	56° 30′	E.	,, ,, ,,	—
528	55° 30′	E.	Woodlands.	—
542	55°	E.	Leixlip.	—
555	58°	E.	Feltrim Quarry.	—

Number of Directions observed, 6.

$336° \, 30' \div 6 = 56° \cdot 05'$ E. mean value. True bearing, 34° 45′ E.

285	62° 30′	E.	Malahide Station Quarry.	—
296	60° 30′	E.	St. Dolough's Quarry.	—
387	62° 30′	E.	Donabate Coast.	—
470	60°	E.	Skerries Coast.	—

Number of Directions observed, 4.

$246° \div 4 = 61°$ E. mean value. True bearing, 39° 40′ E.

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
286	67° 30′	E.	Malahide Station Quarry.	—
370	64° 30′	E.	,, Coast.	—
385	65°	E.	Donabate Coast.	—
386	67° 30′	E.	,, ,,	—
395	67° 30′	E.	,, ,,	—
532	68° 30′	E.	Rathgar Quarry.	—

Number of Directions observed, 6.

400° 30′ ÷ 6 = 66° 45′ E. mean value. True bearing, 45° 25′ E.

363	74°	E.	Malahide Shore.	—
372	72° 30′	E.	,, ,,	—
424	75° 30′	E.	Donabate Coast.	—
260	77°	E.	Sandyford.	—
293	77° 30′	E.	St. Dolough's Quarry.	—

Number of Directions observed, 5.

376° 30′ ÷ 5 = 75° 18′ E. mean value. True bearing, 53° 58′ E.

288	86°	E.	Malahide Station Quarry.	—
289	84°	E.	,, ,, ,,	—
341	85°	E.	Malahide Shore.	—

Number of Directions observed, 3.

255° ÷ 3 = 85° E. mean value. True bearing, 63° 40′ E.

270	90°	W.	Malahide Quarry.	—
281	92°	W.	Malahide Coast.	—
283	86°	W.	,, ,,	—
292	93°	W.	St. Dolough's Quarry.	—
399	87°	W.	Donabate Coast.	—
397	90° 30′	W.	,, ,,	—
408	88°	W.	,, ,,	—
505	88°	W.	Palmerstown Quarry.	—
508	87° 30′	W.	,, ,,	—
517	91° 30′	W.	Lucan.	—
547	89°	W.	Feltrim Quarry.	—
548	92° 30′	W.	,, ,,	—
498	88°	W.	Raheny Quarry.	—
550	92°	W.	Feltrim Quarry.	—

Number of Directions observed, 14.

1255° ÷ 14 = 89° 38′ W. mean value. True bearing, $\begin{cases} 110° \ 58' \text{ W.} \\ 69° \ {\cdot}02' \text{ E.} \end{cases}$

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
280	81°	W.	Malahide Station Quarry.	—
312	78°	W.	Malahide Coast.	—
356	79°	W.	,, ,,	—
358	84°	W.	,, ,,	—
359	85°	W.	,, ,,	—
381	80°	W.	,, ,,	—
384	82° 30′	W.	Donabate Coast.	—
389	83° 30′	W.	,, ,,	—
476	78°	W.	Donnybrook, Dodder River.	—
478	78° 30′	W.	,, ,, ,,	—
497	78° 30′	W.	Gollarstown Quarry.	—
572	83°	W.	Cork College Quarry.	—

Number of Directions observed, 12.

971° ÷ 12 = 80° 54′ W. mean value. True bearing, { 102° 14′ W. / 77° 46′ E.

265	71°	W.	Killester Quarry.	—
284	68°	W.	Malahide Quarry.	—
313	70° 30′	W.	Malahide Coast.	—
349	72° 30′	W.	,, ,,	—
416	72° 30′	W.	Rush Coast.	—
420	75° 30′	W.	Rush Harbour.	—
427	73° 30′	W.	Rush Strand (North).	—
472	66° 30′	W.	Donnybrook, Dodder River.	—
564	69°	W.	Crumlin Sand Quarry.	—

Number of Directions observed, 9.

639° ÷ 9 = 71° W. mean value. True bearing, { 92° 20′ W. / 87° 40′ E.

379	62° 30′	W.	Malahide Coast.	—

True bearing, 83° 50′ W.

343	55°	W.	Malahide Shore.	Fault.
357	56° 30′	W.	,, ,,	—
368	59° 30′	W.	,, ,,	—
383	57° 30′	W.	Donabate Coast.	—
452	56°	W.	Skerries Coast.	—
525	55°	W.	Woodlands.	—
526	57° 30′	W.	,,	—
563	56°	W.	Kimmage Quarries.	—

Number of Directions observed, 8.

453° ÷ 8 = 56° 37′ W. mean value. True bearing, 77° 57′ W.

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
261	47° 30′	W.	Sandyford.	—
262	45° 30′	W.	”	—
263	49° 30′	W.	”	—
449	47° 30′	W.	Lough Shinney Coast.	—
556	48°	W.	Feltrim Quarry.	—
558	47° 30′	W.	” ”	—

Number of Directions observed, 6.

285° 30′ ÷ 6 = 47° 35′ W. mean value. True bearing, 68° 55′ W.

503	38°	W.	Palmerstown.	—
506	38°	W.	”	—
507	37°	W.	”	—
510	41°	W.	”	—
511	40°	W.	”	—
512	40°	W.	”	—
514	41° 30′	W.	”	—

Number of Directions observed, 7.

275° 30′ ÷ 7 = 39° 21′ W. mean value. True bearing, 60° 41′ W.

433	34° 30′	W.	Drumanagh Promontory.	—
434	33° 30′	W.	” ”	—
435	32° 30′	W.	” ”	—
502	34° 30′	W.	Palmerstown.	—

Number of Directions observed, 4.

135° ÷ 4 = 33° 45′ W. mean value. True bearing, 55° ·05′ W.

400	27° 30′	W.	Donabate Coast.	—
425	27° 30′	W.	” ”	—
426	29°	W.	” ”	—
432	26° 30′	W.	Drumanagh Coast.	—
439	28° 30′	W.	Lough Shinney Coast.	—
440	28° 30′	W.	” ” ”	—
456	29° 30′	W.	Skerries Coast.	—
492	26°	W.	Gollarstown Bridge.	—
493	28° 30′	W.	” ”	—
519	28° 30′	W.	Lucan.	—
544	28° 30′	W.	Feltrim Quarry.	—

Number of Directions observed, 11.

308° 30′ ÷ 11 = 28° ·02′ W. mean value. True bearing, 49° 22′ W.

355	25° 30′	W.	Malahide Coast.	—
378	24° 30′	W.	” ”	—
380	24° 30′	W.	” ”	—
422	23° 30′	W.	Rush Coast.	—

No. of Jointing.	Magnetic Bearing.		Locality of Occurrence.	Observations.
428	25° 30′	W.	Giant's Hill, Rush Coast.	—
479	22° 30′	W.	Clonsilla Bridge.	—
543	25° 30′	W.	Rathgar Quarry.	—

Number of Directions observed, 7.

171° 30′ ÷ 7 = 24° 30′ W. mean value. True bearing, 46° 10′ W.

258	8° 30′	W.	Sandyford.	—
259	10° 30′	W.	,,	—
270	9°	W.	Malahide Station Quarry.	—
291	8°	W.	,, ,, ,,	—
304	6°	W.	Malahide Coast.	—
367	7° 30′	W.	,, ,,	—
459	8° 30′	W.	Lough Shinney Coast.	—
460	6° 30′	W.	,, ,, ,,	—
481	7° 30′	W.	Dodder River (Milltown).	—

Number of Directions observed, 9.

72° ÷ 9 = 8° W. mean value. True bearing, 29° 20′ W.

457	14° 30′	W.	Skerries Coast.	—
353	12°	W.	Malahide Coast.	—
373	14° 30′	W.	,, ,,	—

Number of Directions observed, 3.

41° ÷ 3 = 13° 39′ W. mean value. True bearing, 34° 59′ W.

340	19°	W.	Malahide Shore.	—
482	16° 30′	W.	Clonsilla Bridge.	—
391	20°	W.	Donabate Coast.	—

Number of Directions observed, 3.

55° 50′ ÷ 3 = 18° 30′ W. mean value. True bearing, 39° 50′ W.

332	3° 30′	W.	Malahide Coast.	—
351	3° 30′	W.	,, ,,	—
352	1°	W.	,, ,,	—
360	4°	W.	,, ,,	—
369	3°	W.	,, ,,	—
416	4° 30′	W.	Donabate Coast.	—
494	4° 30′	W.	Gollarstown Bridge.	—
520	2° 30′	W.	Lucan.	—

Number of Directions observed, 8.

26° 30′ ÷ 8 = 3° 18′ W. mean value. True bearing, 24° 38′ W.

Summarizing these results, comparing them with those obtained in 1880, and taking the mean directions for the two series of observations, the annexed Table is obtained, relative to which the following observations may be made:—

EASTERLY DIRECTIONS.

1880.		1888.		Mean Values.		
Directions.	Number observed.	Directions.	Number observed.	Directions.	Total Number observed.	Order of Frequency.
1° 55′	6	3° 44′	7	2° 53′	13	XIV.
5 43	9	6 19	13	5 46	22	VII.
10 19	7	10 38	28	10 34	35	III.
16 23	26	—	—	16 23	26	V.
21 29	13	19 40	25	20 16	38	II.
25 50	3	25 17	4	25 31	7	XIX.
30 8	4	30 42	11	30 33	15	XII.
35 36	5	34 35	6	35 7	11	XVI.
—	—	39 40	4	39 40	4	XXI.
48 30	4	45 25	6	46 39	10	XVII.
—	—	53 58	5	53 58	5	XX.
61 30	1	63 40	3	63 7	4	XXI.
72 35	5	69 2	14	69 57	19	X.
81 45	2	77 46	12	79 45	13	XIV.
85 10	3	87 40	9	87 1	12	XV.

WESTERLY DIRECTIONS.

1880.		1888.		Mean Values.		
Directions.	Number observed.	Directions.	Number observed.	Directions.	Total Number observed.	Order of Frequency.
—	—	0° 56′	5	0° 56′	5	XX.
1° 54′	5	1 14	10	1 27	15	XII.
5 26	6	6 57	14	6 5	20	IX.
9 27	10	—	—	9 27	10	XVII.
14 17	5	13 47	34	13 50	39	I.
21 40	3	19 16	20	19 31	23	VI.
25 52	19	24 38	8	25 30	27	IV.
29 11	12	29 20	9	29 15	21	VIII.
34 27	5	34 59	3	34 39	8	XVIII.
39 57	12	39 59	3	39 57	15	XII.
43 51	14	—	—	43 51	14	XIII.
47 42	10	46 10	7	47 5	17	XI.
50 12	11	49 22	11	49 47	22	VII.
—	—	55 5	4	55 5	4	XXI.
59 24	5	60 41	7	60 19	12	XV.
70 39	7	—	—	70 39	7	XIX.
—	—	73 59	10	73 59	10	XVII.
78 15	6	77 57	8	78 4	14	XIII.
84 55	6	83 50	1	84 45	7	XIX.
89 45	12	—	—	89 45	12	XV.

It will be remarked, in the first place, that *only five new directions* have been added to the series of 1880, and that in the main there is a fair concordance between the sets of directions observed in the two years. It is presumable, therefore, that were the survey of the various systems of jointing extended over all Ireland, the total number of distinct systems would be limited, and perhaps be not much in excess of the number observed in the district to which the present observations apply.

Considering the systems of jointing as regards frequency of occurrence, the Table shows that the most frequent, between Malahide and Skerries, and indeed in the district of observation, is N. 13° 50′ W., which is so well marked and so frequent along the coast of Donabate. This direction represents the coast line at Skerries and the general direction of the coast between Howth and Dunany Point. It is clear, therefore, that the most frequent direction of jointing in the district observed represents the neighbouring coast line. The prolongation of this direction represents the valley in which runs the Newry canal, the N. W. shore of Lough Neagh, and the course of the Bann river. Its further extension northwards cuts the east coast of Iceland. A parallel to this direction through Wicklow Head northwards represents the coast line between this point and Killiney, and traverses a certain number of localities marked by the occurrence of earthquakes, such as Wicklow, Bray, Kingstown, Clontarf, and, in the extreme north, the promontory of Innishowen. It would appear that further inland this direction is not only observable, but remarkable by its frequency and regularity. Thus in the Memoirs of the Geological Survey (data and description to accompany quarter sheet 45 S.E., p. 21) mention is made of "numerous well-defined joints striking N. 10° W."; also in memoir accompanying quarter sheet 45 S.W., p. 23, describing the district W. of Kildowery and Shanballymise, the beds are said to be "jointed in lines running either N. and S., or 15° to W. of N." Also in Memoir accompanying sheet 46 N.W., p. 20: "To the N.W. of Drangan, in the townland of Ballylusky, numerous very regular and smooth joints, striking N. 10° W., cut across the beds. To the south of this locality, and distant about one mile, beds occur, the most remarkable feature of these beds being 'the very regular manner in which they are jointed.' 'These joint planes have a strike of N. and S., and E. and W., varying occasionally 10° in either direction,'" &c.

As however all the observations of dips and directions mentioned by this observer are given in round numbers, and with approximations of not more than five degrees, it is evident that this direction N. 10° W. may be in reality any direction between 5° W. and 15° W., and in all probability really represents that found in the neighbourhood of Dublin, N. 13° 50′ W. This view will appear to be sustainable from the consideration of the directions observed in the limestone quarries immediately E. of the Queen's College, Cork. Here may be remarked, jointing, both frequent and well-marked, giving rise in one place to the Dolomitization of the beds, the mean direction found for them was

N. 12°·05 W., and, as shown, fully corresponds to that observed about Dublin. The parallelism is very remarkable, and the very nature of the joints in these quarries, very smooth and even, and generally vertical, corresponds to a similar character of jointing about Dublin. Similar jointing was observed in other localities about Cork. How far westward it can be found present is a question of great interest, and to a certain extent connected with that of the former extension of Ireland to the West, since the correspondence of this direction with a marked coast line implies that subsidence took place along these lines. If this direction of jointing be found prevalent in the S. W. of Ireland to any marked extent, there would be a fair ground for presuming that the country once extended in that direction, and that successive earthquakes, succeeded by subsidences, have reduced it to its present configuration. That earthquakes have taken place along this system of jointing in the S. W. of Ireland may in some degree be inferred from the fact that a line parallel to this direction connects Cork and the neighbourhood of Tuam, at both of which places earthquake shocks have been felt in recent times. No other line would do so with sufficient approximation.

It may be furthermore remarked that, according to the Admiralty Chart of the British Isles (1879), a part of the "Vidal Bank," which limits to the N. W. the plateau of the British Isles, presents a lineal outline having this direction, and presumably corresponding to great lines of subsidence, having given rise to the great Atlantic depression which commences there.

Finally, quite recently most interesting observations as to the intimate relation existing between the jointing and earthquakes in the Salt Lake territory, United States, have been made, and may be found in *Nature*, No. 732, vol. 29, p. 45 (November 8, 1883), fully bearing out the connexion which I here endeavour to establish for Ireland, and which gives the study of jointing such a real interest and importance.

II.—The second most frequent direction observed, that of 20° 16′ E., represents the coast line between Mizen Head and Wicklow Head, a portion of the Skerries coast, and the direction of the east coast of the Solway Firth, between St. Bee's Head and Maryport. It is also represented by a line joining St. David's Head, in Wales, and Braichy Pwll; also by the direction of the N. W. coast of Scotland, between Buchanness and Arbuthnot. Its further extension northwards runs parallel to the coast of Norway.

III.—The third direction in order of frequency, N. 10° 34′ E., is not markedly represented by any part of the coast line of the eastern coast of Ireland, except by the general direction between Baldoyle and Skerries; but farther north in Scotland it corresponds very exactly to the direction of the E. and W. coasts of the promontory of Kintyre.

IV.—The direction 25° 30′ W. may be represented by a line drawn from the centre of Lambay Island to Dunany Point. It corresponds with main faulting in the Mourne Mountains, and also with a well-marked line of faulting which occurs at Ballinakill, Queen's Co.; also with a line of faulting noted as occurring to the south of Kanturk.

V.—The direction N. 16° 23′ E., observed and remarked on in the Paper of 1880, does not come out amongst those observed this year. To the circumstance of its representing the coast line between Carnsore Point and Wicklow Head very exactly, as noted in the Paper of 1880, there may be added the fact that the Admiralty Chart of the British Isles, already referred to, shows by the soundings the existence of a well-marked line of depression in the Irish Sea, extending from the Scilly Islands to opposite Holyhead, the direction of which very distinctly corresponds with that of this system of jointing, and probably represents it in its greatest intensity.

VI.—The direction N. 19° 31′ W. represents the direction of the coast between Lambay Head and Soldier's Point, at the entrance of Dundalk harbour. It traverses the Mourne Mountains, corresponding very closely with the direction of the two great faults which are such marked features in the structure of these mountains, the one lying between Silver Bridge and Belleek, and the other corresponding to the line of the Newry canal. Further north it represents the general direction of the boundary of the chalk between Lough Neagh and Lough Foyle. Its extension northwards passes through Iceland in the neighbourhood of Vatna Jokul; while its prolongation southwards passes through the S. W. extremity of Pembrokeshire, Launceston in Cornwall, passes between Vannes and L'Orient in Brittany, also at Bayonne, and cuts the coast of Valencia in points marked by the recurrence of earthquakes. This direction is parallel to the coast line great circle *West Coast of Africa*, which passes at Cork, and also to the well-marked seismic line, which extends from the Pic du Midi in the Pyrenees to Anglesea in North Wales.

VII.—The direction N. 5° 46′ E. agrees so closely with the value 5° 43′, found in 1880, that the same remarks as then made apply; it is, however, more frequent in the district observed this year. It represents a well-marked line of seismic action in its extensions southwards along the coast of Portugal.

The direction N. 49° 47′ W., equally prevalent, will be found to correspond with the coast line of Bray Head. This direction extended passes between Woodlands and Lucan, at which latter place it has been observed. Further N. W. it corresponds with the direction of the hills to the N. E. of Clonymeath river, to part of which it is parallel. It is also the direction of the principal Eurite veins and dykes of Killiney quarries, and further to the south corresponds to the

direction of the Glenmalure and Avonbeg rivers, down to the Meeting of the Waters.

VIII.—N. 29° 15′ W. This direction corresponds to certain dykes marked as occurring in the Co. Armagh; also with the fault lying to the E. of Gallion Meigh (Mourne Mountains); also with the southern part of the fault represented by the direction of the Newry canal; also with dykes at Rosstrevor and others to the E. in the district of Mourne. It represents very accurately the direction of the coast line from Donaghadee to Bruce's Castle on the N.E. point of Rathlin Island. The direction parallel to this, which passes through Lough Neagh and Innishowen, Co. Derry (an earthquake locality), traverses Iceland at Hecla, or in the immediate vicinity, and on its extension to the S. would correspond with the western coast line of the department of La Manche in France.

IX.—N. 6° 5′ W.

X.—N. 69° 57′ E. This direction is remarkable from many points of view. It occurs at Palmerstown, and being thence extended to the S. W., it will be found to correspond very exactly with a line of fault marked as occurring in Mount Erin, King's and Queen's Cos., this in its extension to the S. W. passes along the S. side of the mouth of the Shannon. A parallel to this direction from Feltrim, where this system of jointing is observable, corresponds very exactly with the direction of the N. side of the Shannon mouth, between Kilclogher Head and Corless Point, corresponding also with the line of contact of the old red sandstone and carboniferous formations to the S. of Lough O'Grady, Co. Clare. This line I had deduced theoretically from the great circle ("Southern boundary of tertiary formation, United States") by the angular relation, 40°, which it makes therewith. It also corresponds very correctly with the marked line of faulting indicated as occurring in the Kilkenny and Carlow coal-field. It furthermore corresponds with the junction of the carboniferous limestone, with the granite and lower silurian in the Co. Dublin, between Roebuck and Allenton; also with the trap dyke system of the Co. Waterford. Lastly, it represents the direction of the southern coast line of Ireland, from Carnsore Point, in Co. Waterford, to Galley Head, Co. Cork.

XI.—N. 47° 05′ W. This direction represents the Balbriggan coast, from Shennick Island to opposite Cargee Rocks.

XII.—N. 39° 57′ W. and N. 30° 30′ E. The very remarkable direction N. 30° 30′ E. is that of the eastern boundary of the granite mass which traverses the counties Wicklow and Carlow. It is also that of the eastern boundary of the chloritic slates of the Co. Waterford from Tramore to Waterford. It also represents accurately the direction of the patch of old red sandstone occurring in the eastern

part of the Co. Roscommon, the continuation of which northwards represents the S. E. boundary of the same formation in the Co. Fermanagh. It corresponds likewise with the western boundary of the same formation in the Co. Clare, and represents the coast line of Clare from Kilkee Bay to Black Head. It thus limits to the east and to the west the remarkable lozenge or parallelogram formed by the N. coast of Galway Bay, the course of the Shannon from Loop Head to Foynes in the south, the west coast of Clare, and the boundary line of the Loughrea and Leitrim mountains, composed mainly of old red sandstone. In the vicinity of Dublin it is well represented by a very remarkable fault, which occurs on the western side of Ireland's Eye, and which is distinctly visible from the main land. This line was deduced theoretically from the great circle, "Southern boundary of the tertiary formation, United States," by the angle 80°, which it makes therewith. The western boundary of the Roscommon old red sandstone patch, produced southwards, cuts this great circle and that of the W. coast of Africa at their intersection, and so far has a theoretical interest.

XIII.—N. 79° 11′ E., 78° 4′ W., and 43° 51′ W. If the direction N. 79° 11′ E., which occurs at Malahide, be extended westward, it will pass south of the boss of basalt occurring near Philipstown, King's Co., will correspond with the fault marked on the Survey map as occurring at the N. E. limit of Slieve Aughty, and will cut the W. coast of Ireland at Doolin point, where it makes an angle of 40° with the southern coast line of Innismore Island, the largest and most westerly of the Arran Islands. This direction forms portions of the outline of the northern coast of Galway Bay. That part which passes at Cashla Bay, being extended eastward, cuts the eastern coast of Ireland at Laytown, running parallel to the line of junction of the lower silurian with the carboniferous formation. The middle fault of the Slieve Aughty series is also parallel to this direction, and corresponds to the lines of jointing observed at Donnybrook (478, 479). It is also parallel to the southern contact of the Slieve Aughty old red sandstone with the carboniferous formation. The remarkable fault which runs from O'Brien's Bridge to Silvermines, Co. Tipperary, and which is mineralized all along its extent, corresponds also with this direction, and would seem to be the continuation of the system of joints having given rise to the Shannon estuary. The direction of this great Silvermines fault, being extended eastward, traverses the northern part of the Queen's Co. and Kilkenny coal-field, and corresponds with the break in, or contraction of, the granite range of the Wicklow and Carlow mountains, occurring in the vicinity of Lugnaquilla, as shown on the Geological map. Further southwards this direction shows itself in the lines of contact of the old red sandstone with the carboniferous formation (N. coast of Dingle Bay), and of the old red and lower carboniferous slates which run from Sheep Head to Passage, as also the contact of the same rocks at Skibbereen. Finally it corresponds with the part

of the southern coast line lying between Galley Head and the N. end of Clear Island.

The direction N. 79° 11′ E. corresponds very fairly with that of the main barytes lode of Bantry, as described by Mr. Hardman in a Paper read before the Royal Geological Society of Ireland in 1878. He gives the direction of the main lode as N. 80° E.

The direction N. 78° 4′ W. is not markedly present on the eastern side of Ireland, but would fairly represent the line of contact of the mica slates of Galway, lying to the north of the granite.

The direction N. 43° 51′ W. represents the southern shore of Lough Erne, and also corresponds to a fault which runs from Lugnabrick to Bengorm, Co. Galway. This direction would also apparently be the direction of the main lode of barytes situated in the S. W. part of Cork, between Dunmannus Bay and Roaring Water, and stated by Captain Triphook (*Proceedings*, Royal Geological Society of Ireland, vol. vi., p. 218, 1853–54) to be N. 45° W.

XIV.—N. 2° 53′ E. This direction is represented on the coast by the line from Donabate to Shennick Island. It also corresponds with the two faults limiting, east and west, a tongue of carboniferous limestone which occurs at Kingscourt, and also with the fault marked as extending between Knocktopher and Kilkenny city.

XV.—N. 87° 1′ E. This direction represents very accurately the northern coast of Galway Bay, between Clogmore Point and Salt Hill; and, being extended eastward, traverses the mass of trap rock which occurs at Philipstown, and cuts the east coast on the north side of Howth, where this direction frequently and markedly occurs (see *Proceedings*, R. I. Academy, 2 ser. vol. ii. Science, pp. 300–302). It is also present at Donnybrook, in the Dodder bed, and, being extended thence westward, passes near Crumlin, where it occurs, and crosses Galway Bay, so as to touch the northern end of Innismore Island. The occurrence at Crumlin is remarkable. There occurs there a sand-hill which has been worked for many years; and on the escarped face, at the south-west end of the quarry, there appears a rib or joint having this direction, and which I take to be the result of the movement of the soil in the manner of an earthquake. If this view be correct, it would indicate that movements of ground, having given rise to this line of jointing, took place subsequently to the formation of these hills, which are presumably quaternary or even later. That a great line of depression traverses Ireland from Dublin to Galway is evident, whether represented by one single system of line of fracture or by several remains for determination. To the south it represents the southern shore line of Carrickaholt Bay, and the line of contact of the old red sandstone with the carboniferous from Cork to Youghal Bay.

N. 60° 19′ W. represents the southern coast of Innismore Island.

XVI.—N. 35° 7′ E.

XVII.—N. 46° 39′ E. This direction forms the coast line from Dundalk Bay to Downpatrick. It also represents correctly the direction of the valley of Donegal county, and contact of the granite with the quartz rocks there.

This direction, which occurs at Donabate, being extended thence eastward, corresponds with the coast of the Isle of Man at Peel, and forms the general direction of the southern contact thereof.

It also represents the direction of the remarkable line of trap rocks which extend from Antrim by Red Bay, the Mull of Kantyre, the south-east coast of Arran Island (Scotland), and Renfrewshire, to Montrose, with the parallel band of Devonian rocks in Stirling, Perth, and Forfarshire. The promontory of Carnarvon is parallel to it.

N. 9° 27′ W. This direction was noticed in the Paper of 1880 (p. 307 of *Proceedings*, 2nd ser. vol. iii., Science).

N. 73° 59′ W. This direction represents very fairly that of the depression existing between Dublin and Mullingar, and along which the Midland and Great Western Railway runs, as also the Grand Canal, on whose banks, at Gollastown Bridge, this direction of jointing is noticeable.

XVIII.—N. 34° 39′ W. This direction represents very correctly the north-east coast of Ireland, from Copeland Island to Bull Point on Rathlin Island. It also represents the main jointing or dykes of the Mourne Mountains at the head of Carlingford Lough. Being extended northwards, it traverses Iceland, parallel to the south-west coast, and near Reykyavick, a point continually subject to earthquake shocks. It also represents very correctly the direction of the east coast of England between the Wash and the Firth of Forth.

XIX.—N. 25° 31′ E. and N. 70° 39′ W.

The direction N. 25° 31′ E. corresponds fairly with that of the coast line between Courtown Harbour and Wicklow Head.

N. 70° 39′ W. This direction is that of the remarkable dykes represented as occurring along the Mayo coast, between Killala Bay and Broad Haven. It is further interesting as representing with accuracy the theoretical Great Circle ("South boundary of the tertiary formation, United States," already referred to.

XX.—N. 53° 58′ E. This direction corresponds to the line of contact of the old red sandstone with the silurian at Newcastle, Co. Dublin. It also represents the faults occurring to the north-east of Roscrea, and to the south-west of Borris-in-Ossory; also the direction of the fault occurring to the south-east of Antrim; also the general direction of the band of carboniferous limestone which stretches across Ireland from Galway to Lough Neagh, and which is so markedly

traversed by greenstone or trap dykes, having practically the same direction. It also represents the direction of the band of feldstone which occurs to the south-west of Enniscorthy.

N. 0° 56′ W. This direction is in part represented by the line of fault occurring between Waterford and Kilkenny. It corresponds to the theoretical line which is given by an angle of 70° with the Great Circle ("South boundary, tertiary formation, United States").

XXI.—N. 63° 7′ E. This direction represents the axis of Slieve Caha Mountains between Bantry and Kenmare Bay; as also the direction of the line of contact of upper and lower silurian slates, south-west of Killoughter.

N. 66° 8′ E. represents very correctly the remarkable tongue of Old Red, which stretches from Bantry to Sheep Head, as also that of the parallel line of contact on the south side of Dunmannus Bay.

It may be of interest to bring together the directions which represent the faults, dykes, and remarkable joints observed; and the following list gives the results for the two sets of observations:—

No. of observed Directions.	Faults, Dykes, and remarkable Joints.	Locality where observed.	Magnetic Bearing.	True Bearing.
416	Fault, ...	Donabate Coast, .	4°–5° E.	16° 50′ W.
392	Well-marked fault, .	Donabate Coast, .	7°–8° E.	13° 50′ W.
396	Great fault, . . .	,, ,, .	7°–8° E.	
401	,, ,, and cave, .	,, ,, .	7°–8° E.	
403	Great fault, . . .	,, ,, .	7°–8° E.	
405	,, ,, . . .	,, ,, .	7°–8° E.	
342	Great Dolomite joint, .	Malahide Coast, .	19°–20° E.	1° 5′ W.
388	Dyke in slate rock, .	Donabate Coast, .	21° E.	
76	Eurite dyke, . .	Killiney Hill, . .	24° E.	3° 25′ E.
423	Fault, ...	Rush Strand, N. side,	25°–26° E.	
213	Great joint, . . .	Howth, S. side, .	28° E.	6° 40′ E.
311	Great joint, with lining, .	Malahide Coast, .	31°–32° E.	10° 40′ E.
522	Great joint, connected with lode.	Woodlands, . .	32°–33° E.	

No of observed Directions.	Faults, Dykes, and remarkable Joints.	Locality where observed.	Magnetic Bearing.	True Bearing.
38	Great open joint, . .	Bullock Harbour, .	38°–39° E.	18° 40′ E.
77	Contact of granite and slate rock,	Killiney Park, . .	39° E.	
79	,, ,, ,, ,, .	,, ,, . .	42° E.	
80	,, ,, ,, ,, .	,, ,, . .	39° 30′ E.	
91	Great joint, . . .	Dalkey Island, . .	38°–40° E.	
223	Great fault, with dislocation,	Howth, S. side, .	38°–39° E.	
225	"Sheep Hole" and Greenstone dyke,	,, ,, .	36°–38° E.	
226	Creek and great joint, .	,, ,, .	35°–38° E.	
314	Great open joint, . .	Malahide Strand, .	41°–42° E.	
561	Dolomite joint, a main one,	Kimmage Quarry, .	41°–42° E.	
562	,, ,, ,, ,, .	,, ,, .	42°–43° E.	
165	Iron lode, . . .	Howth, . . .	40°–45° E.	
33	Main joint, . . .	Sandycove, . .	44° E.	44° 52′ E.
157	Dyke, ...	Howth, Puck's Rock,	46°–47° E.	
402	Dyke in banded shales, .	Donabate Coast, .	45°–46° E.	
549	Great joint, with clay filling,	Feltrim Quarry, .	43°–44° E.	
5	Joint, ...	People's Park, Blackrock,	53° E.	52° 36′ E.
51	Eurite vein, . . .	Bullock Quarry, .	51°–52° E.	
251	Well-marked joint, .	Ireland's Eye, . .	53° E.	
337	Dolomite dyke, . .	Malahide Coast, .	53°–54° E.	
489	Great calcspar lode, .	Gollerstown Bridge, .	52° E.	
395	Great vertical feldspar dyke,	Donabate Coast, .	67°–68° E.	46° 10′ E.
424	Fault, ...	Donabate Coast, .	75°–76° E.	54° 10′ E.
239	Fault, ...	Ireland's Eye, . .	87°–88° E.	66° 10′ E.
204	Great joint, . . .	Howth, S. side, .	3°–4° W.	24° 40′ W.
205	,, ,, ...	,, ,, . .	2°–3° W.	
218	,, open joint, . .	,, ,, . .	3° W.	
221	,, joint, . . .	,, ,, . .	3° W.	
225	Trap rock dyke, . .	,, ,, . .	3°–5° W.	
237	Fault, ...	Drumleck Bay, Howth,	3°–5° W.	
87	Great Eurite vein, . .	Dalkey Island, . .	6°–7° W.	27° 50′ W.
100	Eurite vein, . . .	Dalkey Island, . .	18°–19° W.	39° 50′ W.
120	Great joint, . . .	Dalkey Quarries, .	18° W.	
129	,, dyke, ...	,, ,, .	18° W.	
130	Eurite vein, ...	,, ,, .	17°–18° W.	
138	Great joint, ...	,, ,, .	17°–18° W.	
136	,, ,, ...	,, ,, .	21°–22° W.	
422	Fault cutting shales, .	Donabate Coast, .	23°–24° W.	44° 50′ W.

No. of observed Directions.	Faults, Dykes, and remarkable Joints.	Locality where observed.	Magnetic Bearing.	True Bearing.
140	Great Eurite vein, . .	Dalkey Quarries, .	26°–27° W.	49° 39′ W.
142	,, ,, ,, . .	,, ,, .	28°–30° W.	
143	,, ,, ,, . .	,, ,, .	30° W.	
193	Great joint, . . .	Sutton Shore, . .	30° W.	
208	Joint and fault, . .	Howth, S. side, .	28° W.	
212	,, ,, ...	,, ,, .	27°–28° W.	
400	Fault with dislocation and cave,	Donabate Coast, .	27°–28° W.	
64	Joint and dyke, . .	Killiney (Long Rock),	28° 30′ W.	
71	Eurite vein, . . .	Killiney, ...	33° W.	54° 40′ W.
233	Great vertical joint, .	Howth, S. side, .	33°–34° W.	
434	,, ,, ,, .	,, ,, . .	33°–34° W.	
43	Great open joint, . .	Kingstown Quarry, .	38°–39° W.	59° 30′ W.
52	Quartz vein, . . .	Bullock Quarry, .	37°–38° W.	
201	Great joint, . . .	Howth, S. side, .	38°–39° W.	
144	Great dyke of porphyry,	Dalkey Quarries, .	44° W.	65° 20′ W.
203	Great joint, . . .	Howth, S. side, .	50° W.	70° 5′ W.
449	Well-marked fault, .	Lough Shinney Coast,	47°–48° W.	
151	Lode, ...	Carrickmines, . .	57° W.	76° 33′ W.
247	Contact of quartzite and shales,	Ireland's Eye, . .	50°–56° W.	
343	Fault, ...	Malahide Coast, .	55° W.	
383	Feldspathic lode or dyke,	Donabate Coast, .	57°–58° W.	
410	Fault, ...	,, ,, .	53°–54° W.	
453	Cave on open joint (old copper level), . .	,, ,, .	54°–55° W.	
526	Large joint, . . .	Woodlands, . .	57°–58° W.	
539	Main jointing, . .	Salmon Leap, Leixlip,	53° W.	
563	,, ,, . . .	Kimmage Quarry, .	56° W.	
379	Fault, ...	Malahide Coast, .	62°–63° W.	83° 50′ W.
39	Great open joint, . .	Kingstown Quarry, .	67° W.	89° 35′ W.
166	Marked jointing, . .	Red Rock, Howth, .	69°–70° W.	
254	Contact of quartzites and shales,	Ireland's Eye, N. side,	77° W.	99° 50′ W. = 80° 10′ E.
356	Great fault, . . .	Malahide Coast, .	78°–80° W.	
384	Feldspathic lode, . .	Donabate Coast, .	80°–85° W.	
419	Fault, ...	Rush Harbour Entrance,	75°–76° W.	
399	Great fault, . . .	Donabate Coast, .	87° W.	110° 20′ W. = 69° 40′ E.
408	Fault, ...	,, ,, .	88° W.	
547	Main joint, . . .	Feltrim Quarry, .	89° W.	
550	,, ,, ...	,, ,, .	92° W.	

XIV.—A CATALOGUE OF KNOWN VARIABLE STARS. WITH NOTES AND OBSERVATIONS. By J. E. GORE, M. R. I. A., F. R. A. S., Honorary Member of the Liverpool Astronomical Society.

[Read, January 28, 1884.]

THE following Catalogue of Variable Stars will be found, I think, to include all those stars which have been certainly proved to be variable in light. The periods of most of them have been determined with a considerable degree of accuracy; but in the case of several stars included in the list, although their variability has been placed beyond question by the accordant observations of several independent observers, the exact length of their periods and the nature of their light curves has not as yet been accurately determined. The following stars are included in the latter class, and continuous observations of them by observers in different parts of the world are much to be desired :—α Cassiopeiæ (No. 6); S Persei (No. 15); R Doradus (No. 25); R. Eridani (No. 27); ε Aurigæ (No. 29); S (64) Eridani (No. 31); S Aurigæ (No. 33); T Orionis (No. 36); R Lyncis (No. 42); S Puppis (No. 53); T Puppis (No. 54); R Velorum (No. 67); R Antliæ (No. 68); S Carinæ (No. 69); U Hydræ (No. 70); T Carinæ (No. 73); R Crateris (No. 74); Y Virginis (No. 91); R Centauri (No. 92); V Coronæ (No. 109); V Herculis (No. 124); h′ (51) Sagittarii (No. 150); R Cephei (No. 164); S Capricorni (No. 165); 63 Cygni (No. 174); μ Cephei (No. 179); U Aquarii (No. 182); and U Cassiopeiæ (No. 190).

Argelander's nomenclature has been followed in designating those variables lately discovered, and which possessed no distinguishing letter or number. In the case of Flamsteed's stars, his numbers have been retained.

The notes on the older variables are chiefly derived from Professor Schönfeld's *Zweiter Catalog von veränderlichen Sternen* (Mannheim, 1875). To these have been added later observations by other observers, and further information derived from various sources.

I have added some observations of my own on some of the more remarkable variables.

The positions of the variables have been brought up to 1880·0, and the Epochs of Maxima and Minima are chiefly from Schönfeld's Catalogue.

Several of the new variables were discovered at Cordoba, and the particulars respecting them have been taken from Dr. Gould's *Uranometria Argentina.*

A CATALOGUE OF K

No.	Star.	R. A., 1880.			Decl., 1880.			Change of Magnitude.		Mea I
								Max.	Min.	
		H.	M.	S.	°	′	″			
1	T Cassiopeiæ, . . .	0	16	45	+ 55	7	33	6·5–7·0	11, 11·2	·
2	R Andromedæ, . .	0	17	44	+ 37	54	39	5·6–8·6	< 12·8	4
3	S Ceti, ...	0	17	57	− 9	59	39	7·0–8·0	< 10·7	3
4	B Cassiopeiæ, . . .	0	18	9	+ 63	28	51	> 1	?	
5	T Piscium, . . .	0	25	46	+ 13	56	15	9·5–10·2	10·5–11·0	Irr
6	α Cassiopeiæ, . . .	0	33	42	+ 55	52	45	2·2	2·8	Irr
7	U Cephei, ...	0	52	35	+ 81	13	48	7·2	9·1–9·4	2·
8	S Cassiopeiæ, . . .	1	10	52	+ 71	58	48	6·7–8·5	< 13	(
9	S Piscium, . . .	1	11	18	+ 8	17	54	8·8–9·3	< 13	40
10	R Sculptoris, . . .	1	21	27	− 33	10	24	5·75	7·75	3
11	R Piscium, . . .	1	24	27	+ 2	15	39	7·4–8·3	< 12·5	3
12	S Arietis, ...	1	58	11	+ 11	56	57	9·1–9·8	< 13	2
13	R Arietis, ...	2	9	18	+ 24	29	48	7·6–8·5	11·9–12·7	1
14	ο (Mira) Ceti, . .	2	13	18	− 3	31	18	1·7–5·0	8·9	33
15	S Persei, ...	2	14	15	+ 58	2	12	8·5	< 9·7	
16	R Ceti, ...	2	19	55	− 0	43	6	7·9–8·7	< 12·8	1
17	T Arietis, ...	2	41	38	+ 17	0	36	7·9–8·2	9·4–9·7	3
18	ρ Persei, ...	2	57	29	+ 38	22	30	3·4	4·2	Irre
19	β Persei (Algol), . .	3	0	22	+ 40	29	36	2·2	3·7	2·8
20	R Persei, ...	3	22	25	+ 35	15	21	8·1–9·2	12·5	20
21	λ Tauri, ...	3	54	1	+ 12	8	54	3·4	4·2	3·
22	T Tauri, ...	4	15	0	+ 19	15	3	9·2–11·5	< 12·8	Irreg
23	R Tauri, ...	4	21	43	+ 9	53	36	7·4–9·0	< 13·0	32
24	S Tauri, ...	4	22	38	+ 9	40	48	9·9	< 13	3
25	R Doradus, . . .	4	35	22	− 62	18	47	$5\frac{1}{2}$	$6\frac{1}{2}$	·
26	V Tauri, ...	4	45	6	+ 17	20	9	8·3–9·0	< 12·8	16

ABLE STARS.

h of Max. G. M. T.	Epoch of Min. G. M. T.		Discoverer.		Remarks.
Oct. 2.	1873.	Jan. 29.	Krüger,	1870.	
April 29·8.		..	Argelander,	1858.	
Dec. 22·2.		..	Borrelly,	1872.	
..		..	Tycho Brahé,	1572.	
..		..	R. Luther,	1855.	A maximum, 1872, Dec. 1.
..		..	Birt,	1831.	
..		..	Ceraski,	1880.	Schmidt's period is 2·49277 days.
May 8.		..	Argelander,	1861.	
Jan. 5·7.		..	Hind,	1851.	
..		..	Gould.		
Nov. 30.		..	Hind.	1850.	
Mar. 17.		..	C. H. F. Peters,	1865.	
Aug. 28·5.	1866.	May 31·6.	Argelander,	1857.	
Nov. 25·5.	1866.	Aug. 8.	D. Fabricius,	1596.	For formula of sines, *see* Notes.
..		..	Krüger,	1873.	
Oct. 31·4·		..	Argelander,	1867.	
Mar. 11.	1872.	Nov. 8.	Auwers,	1870.	
..		..	Schmidt,	1854.	
..	1869.	Nov. 9. $3^h\ 39^m\ 25^s$.	Montanari,	1669.	
Jan. 17.		..	Schönfeld,	1861.	
..	1866.	Dec. 31. $12^h\ 34^m$.	Baxendell,	1848.	
..		..	Auwers, Chacornac, and Hind	1861.	
April 30·8.		..	Hind,	1849.	
Feb. 21.		..	Oudemans,	1855.	
..		..	Thome.		
Sept. 24·3.		..	Auwers,	1871.	

No.	Star.	R. A., 1880.			Decl., 1880.			Change of Magnitude.		Mean … Da…
		H.	M.	S.	°	′	″	Max.	Min.	
27	R Eridani, ...	4	49	55	− 16	36	36	5·4	6·0	..
28	R Orionis, ...	4	52	29	+ 7	56	48	8·7–8·9	< 13	378
29	ε Aurigæ, ...	4	53	21	+ 43	38	42	3·0	4·5 ?	Irreg
30	R Leporis, ...	4	54	9	− 14	59	12	6–7	8·5 ?	437
31	S (64) Eridani, . .	4	54	20	− 12	42	54	4·8	5·7	..
32	R Aurigæ, ...	5	7	37	+ 53	27	0	6·5–7·4	12·7	4
33	S Aurigæ, ...	5	19	12	+ 34	3	18	9·4	< 12	..
34	S Orionis, ...	5	23	5	− 4	47	12	8·3	< 12·3	41
35	δ Orionis, ...	5	25	52	− 0	23	9	2·2	2·7	Irreg
36	T Orionis, ...	5	28	35	+ 10	9	50	5·7 ?	6·7 ?	..
37	α Orionis, ...	5	48	40	+ 7	23	24	1	1·4	Irreg
38	η Geminorum, . .	6	7	38	+ 22	32	30	3·2	3·7–4·2	22
39	T Monocerotis, . .	6	18	48	+ 7	9	0	6·2	7·6	2
40	R Monocerotis, . .	6	32	37	+ 8	50	27	9·5	11·5	Irreg
41	S (15) Monocerotis, .	6	34	23	+ 10	0	15	4·9	5·4	3^d 10
42	R Lyncis, ...	6	51	24	+ 55	29	51	9 ?	< 12·3	[illegible]
43	ζ Geminorum, . .	6	56	59	+ 20	44	42	3·7	4·5	$10^d\ 3^h$
44	R Geminorum, . .	7	0	7	+ 22	53	15	6·6–7·3	< 12·3	37
45	R Canis Minoris, . .	7	2	6	+ 10	12	39	7·2–7·9	9·5–10·0	3
46	L_2 Puppis, . . .	7	9	52	− 44	26	40	3·6	6·3	1
47	U Monocerotis, . .	7	25	4	− 9	31	35	6·0	7·2	.
48	S Canis Minoris, . .	7	26	12	+ 8	34	24	7·2–8·0	< 11	33
49	T Canis Minoris, . .	7	27	20	+ 12	0	0	9·1–9·7	< 13	32
50	S Geminorum, . .	7	35	50	+ 23	43	57	8·2–8·7	< 13	29
51	R Puppis, ...	7	36	14	− 31	23	0	6½	7½	..
52	T Geminorum, . .	7	42	6	+ 24	2	0	8·1–8·7	< 13	28
53	S Puppis, ...	7	43	15	− 47	49	0	7¼	9	..
54	T Puppis, ...	7	44	2	− 40	21	16	6½	7½	..

poch of Max. G. M. T.	Epoch of Min. G. M. T.	Discoverer.	Remarks.
..	..	Gould.	
9. Oct. 18·6.	..	Hind, 1848.	
..	..	Fritsch, 1821.	
4. Mar. 4.	1863. July 18.	Schmidt, 1855.	
..	..	Gould.	
9. Mar. 13.	1868. July 14.	Argelander, 1862.	
..	..	Dunér, 1881.	
..	..	Webb, 1870.	
..	..	Sir J. Herschel, 1834.	
..	..	Thome.	
..	..	Sir J. Herschel, 1840.	
..	1870. April 7.	Schmidt, 1865.	
74. Feb. 28.	1874. Feb. 20.	Davis, 1871.	
..	..	Schmidt, 1861.	
..	..	Winnecke, 1867.	
..	..	Krüger, 1874.	
63. July 17. 4h 52m.	1863. July 12. 4h 30m.	Schmidt, 1847.	
68. Mar. 4.	..	Hind, 1848.	
67. June 17.	1867. Jan. 30.	Argelander, 1855.	= Lalande, 13825.
..	..	Gould,	Lacaille, 2691.
..	..	Gould.	
63. May 6.	..	Hind, 1856.	
72. Feb. 3·6.	..	Schönfeld, 1865.	
65. Nov. 3·2·	..	Hind, 1848.	
..	..	Gould.	
63. Feb. 18·3.	..	Hind, 1848.	
..	..	Gould.	
..	..	Gould.	

No.	Star.	R. A., 1880.			Decl., 1880.			Change of Magnitude.		Mean
		H.	M.	S.	°	′	″	Max.	Min.	Day
55	U Geminorun,. . .	7	47	59	+ 22	18	57	8·9–9·7	13·1	Irreg
56	R Cancri, ...	8	9	57	+ 12	5	33	6·2–8·3	< 11·7	354
57	V Cancri, ...	8	14	53	+ 17	40	0	6·8–7·2	< 12	272
58	U Cancri, ...	8	28	54	+ 19	18	30	8·2–10·4	< 13	305
59	S Cancri, ...	8	37	5	+ 19	27	57	8·2	9·8–11·7	9^{d} 11^{h}
60	S Hydræ, ...	8	47	18	+ 3	31	18	7·5–8·5	< 12·2	256
61	T Cancri, ...	8	49	49	+ 20	18	36	8·2–8·5	9·3–10·5	484
62	T Hydræ, ...	8	49	50	– 8	40	54	7·0–8·1	< 12·5	289
63	R Carinæ, ...	9	29	14	– 62	15	30	4·3–5·4	9·3	313
64	R Leonis Minoris, .	9	38	23	+ 35	3	51	6·1–7·5	< 11·0	374
65	R Leonis, ...	9	41	6	+ 11	59	9	5·2–6·4	9·4–10·0	312
66	*l* Carinæ, ...	9	41	57	– 61	57	12	3·7	5·2	31·2
67	R Velorum, . . .	10	1	38	– 51	36	14	6·5	7·5	..
68	R Antliæ, ...	19	4	35	– 37	8	33	6·5	8	..
69	S Carinæ, ...	10	5	33	– 60	57	45	6¼	9	Several m
70	U Hydræ, ...	10	31	37	– 12	45	39	4·3	6·1	?
71	R. Ursæ Majoris, .	10	36	8	+ 69	24	21	6·0–8·1	12	303
72	η Argûs, ...	10	40	25	– 59	3	6	> I	< 7	?
73	T Carinæ, ...	10	50	30	– 59	52	47	6·2	6·9	?
74	R. Crateris, . . .	10	54	40	– 17	40	48	> 8	< 9	..
75	S Leonis, ...	11	4	39	+ 6	6	54	9·0–9·7	< 13	187
76	T Leonis, ...	11	32	17	+ 4	2	15	10 ?	< 13	..
77	X Virginis,. . . .	11	56	6	+ 9	44	27	7·8 ?	< 10	..
78	R Comæ, ...	11	58	6	+ 19	27	9	7·4–8·0	< 13	363
79	T Virginis, . . .	12	8	27	– 5	22	3	8·0–8·8	< 13	337
80	R Corvi, ...	12	13	25	– 18	35	6	6·8–7·3	< 11·5	318
81	Z Virginis, . . .	12	27	42	– 3	45	40	8·0	14	219
82	T Ursæ Majoris, . .	12	30	56	+ 60	8	57	7·0–8·3	12·2	255

ch of Max. G. M. T.	Epoch of Min. G. M. T.		Discoverer.		Remarks.
..		..	Hind,	1855.	
Mar. 16.		..	Schwerd,	1829.	
Nov. 15.		..	Auwers,	1870.	
Mar. 2.		..	Chacornac,	1853.	
..	1867.	Aug. 31. $14^h\ 3^m$.	Hind,	1848.	
Aug. 28·9.		..	Hind,	1848.	
..	1868.	Aug. 16·6.	Hind,	1850.	
Jan. 26·5.		..	Hind,	1851.	
Dec. 16.	1881.	June 8.	Gould.		
April 1·7.		..	Schönfeld,	1863.	
Jan. 21·3.	1853.	Aug. 26·3.	Koch,	1782.	
..		..	Gould,	1871.	
..		..	Thome.		
..		..	Gould.		
..		..	Gould,	1874.	
..		..	Birmingham, Gould.		
. July 5.		..	Pogson,	1853.	
..		..	Burchell,	1827.	
..		..	Thome,	1874.	
..		..	Winnecke,	1861.	
. Sept. 14·3.		..	Chacornac,	1856.	
..		..	C. H. F. Peters,	1862.	
..		..	C. H. F. Peters,	1871.	
. Oct. 22.		..	Schönfeld,	1856.	
5. Dec. 16.		..	Boguslawski,	1849.	
. Dec. 22·3.		..	Karlinski,	1867.	
..		..	M. M. Henry,	1874.	
8. July 15·8.	1868.	April 1.	Argelander,	1860.	

No.	Star.	R. A., 1880.			Decl., 1880.			Change of Magnitude.		Mean P
								Max.	Min.	Day
		H.	M.	S.	°	′	″			
83	R Virginis, . . .	12	32	25	+ 7	38	57	6·5–7·5	10–10·9	145
84	R Muscæ, ...	12	34	45	– 68	45	0	6·6	7·4	[illegible]
85	S Ursæ Majoris, . .	12	38	41	+ 61	45	3	7·7–8·2	10·2–11·1	22
86	U Virginis, ...	12	45	1	+ 6	12	21	7·7–8·1	12·2–12·8	207
87	W Virginis, . . .	13	19	50	– 2	45	9	8·7–9·2	9·8–10·4	17
88	V Virginis, . . .	13	21	36	– 2	32	57	8·0–9·0	< 13	251
89	R Hydræ, ...	13	23	10	– 22	39	33	4·0–5·5	10 ?	43
90	S Virginis, . . .	13	26	44	– 6	34	33	5·7–7·8	12·5	37
91	Y Virginis, . . .	13	28	28	– 12	35	51	5	8 ?	[illegible]
92	R Centauri, . . .	14	7	56	– 59	21	13	6	10	[illegible]
93	T Bootis, ...	14	8	28	+ 19	37	42	9·7	< 13	[illegible]
94	S Bootis, ...	14	18	51	+ 54	21	18	8·1–8·5	13·2	27
95	R Camelopardii, . .	14	26	41	+ 84	22	27	7·9–8·6	12 ?	26
96	R Bootis, ...	14	31	54	+ 27	15	36	5·9–7·5	11·3–12·2	22
97	δ Libræ, ...	14	54	34	– 8	2	24	4·9	6·1	2d 7h 5
98	T Trian Australis, .	14	58	35	– 68	15	27	7·0	7·4	1 da
99	R Trian Australis, .	15	9	3	– 66	3	18	6·6	8·0	3
100	U Coronæ, ...	15	13	18	+ 32	5	18	7·6	8·8	3d 10h 51
101	S Libræ, ...	15	14	30	– 19	57	12	8·0	12·5 ?	19
102	S Serpentis, . . .	15	16	2	+ 14	44	48	7·6–8·6	12·5 ?	361
103	S Coronæ, ...	15	16	30	+ 31	48	0	6·1–7·8	11·9–12·5	361
104	T Libræ, ...	15	29	16	– 20	45	55	11	?	31
105	U Libræ, ...	15	31	6	– 15	46	38	. .	. .	380
106	Oe. Arg. 14782 Libræ,	15	35	4	– 20	47	32	9	?	342
107	R Coronæ, ...	15	43	38	+ 28	31	33	5·8	13·0	Irreg
108	R Serpentis, . . .	15	45	10	+ 15	29	51	5·6–7·6	< 11	357
109	V Coronæ, ...	15	45	15	+ 39	56	18	7·5	10·5 ?	. .
110	R Libræ, ...	15	46	49	– 15	52	36	9·2–10·0	< 13	723

h of Max. M. T.	Epoch of Min. G. M. T.		Discoverer.		Remarks.
Mar. 31·7.	1853.	Jan. 19·4.	Harding,	1809.	
..		..	Gould,	1871.	
Mar. 14·5.	1866.	Nov. 26·5.	Pogson,	1853.	
June, 29·4.	1866.	Mar. 28·3.	Harding,	1831.	
Ap. 25·667.	1869.	Ap. 17·467.	Schönfeld,	1866.	
Sept. 4.		..	Goldschmidt,	1857.	
Sept. 2·48.		..	Maraldi,	1704.	
May 12·6.		..	Hind,	1852.	
..		..	Schmidt,	1866.	
..		..	Gould,	1871.	
..		..	Baxendell,	1860.	
April 7.		..	Argelander,	1860.	
Aug. 29.		..	Hencke,	1858.	
Mar. 14·5.		..	Argelander,	1858.	
..	1867.	Oct. 25. $9^h\ 14^m$.	Schmidt,	1859.	
..		..	Gould.		
..		..	Gould,	1871.	
..	1871.	Feb. 6.	Winnecke,	1869.	
..		..	Bórrelly,	1872.	
April 5.		..	Harding,	1828.	
July 28.	1867.	Mar. 29.	Hencke,	1860.	
..		..	Peters,	1880.	A. N., 2360.
..		..	Peters,	1880.	A. N., 2360.
..		..	Peters,	1880.	A. N., 2360.
..		..	Pigott,	1795.	
April 25·6.		..	Harding,	1826.	
Sept. 15·6.		..	Dunér,	1878.	No. 361 of Birmingham's Catalogue.
April 8.		..	Pogson,	1858.	

No.	STAR.	R. A., 1880.			Decl., 1880.			Change of Magnitude.		Mean
								Max.	Min.	Da
		H.	M.	S.	°	′	″			
111	T Coronæ, ...	15	54	29	+ 26	15	36	2·0	9·5	?
112	W Scorpii, ...	16	0	19	− 21	12	14	11 ?	?	405
113	R Herculis, . . .	16	0	50	+ 18	41	39	8·0–9·0	< 13	319
114	V Scorpii, ...	16	4	46	− 19	49	24	10 ?	?	220
115	T Scorpii, ...	16	9	54	− 22	40	42	7·0	< 10	?
116	R Scorpii, ...	16	10	30	− 22	39	0	9–10·5	< 12·5	223
117	S Scorpii, ...	16	10	31	− 22	36	0	9·1–10·5	< 12·5	176
118	U Scorpii, ...	16	15	33	− 17	36	3	9 ?	< 12	..
119	U Herculis, . . .	16	20	29	+ 19	10	6	6·6–7·7	11·4–11·6	408
120	X Scorpii, ...	16	22	14	− 19	13	48	..	..	?
121	*g* (30) Herculis, . .	16	24	42	+ 42	8	54	5	6·2	40 to
122	T Ophiucii, . . .	16	26	52	− 15	52	54	10	< 12·5	..
123	S Ophiucii, . . .	16	27	24	− 16	54	24	8·3–9·0	< 12·5	233
124	V Herculis, . . .	16	30	58	+ 37	35	0	8·3	11·0	..
125	R Ursæ Minoris, . .	16	31	32	+ 72	32	12	..	..	..
126	S Herculis, . . .	16	46	27	+ 15	8	39	5·9–6·8	11·5–12·2	303
127	Nova Ophiucii, . .	16	52	48	− 12	42	30	4½	..	?
128	R Ophiucii, . . .	17	0	53	− 15	56	12	7·6–8·1	< 12	302
129	α Herculis,. . . .	17	9	11	+ 14	31	45	3·1	3·9	Irreg
130	U Ophiucii, . . .	17	10	29	+ 1	20	40	6·0	6·7	0d 20h 7
131	u (68) Herculis, . .	17	12	53	+ 33	13	45	4·6	5·4	37 to
132	Nova Ophiucii, . .	17	23	27	− 21	22	42	> 1	?	?
133	X (3) Sagittarii, . .	17	40	0	− 27	47	0	4	6	7
134	W (γ′) Sagittarii, . .	17	57	21	− 29	35	9	5	6·5	7
135	T Herculis, . . .	18	4	33	+ 31	0	9	7·2–8·3	11·4–12·1	165
136	T Serpentis, . . .	18	22	57	+ 6	13	15	9·1–10·0	< 12·8	342
137	V Sagittarii, . . .	18	24	22	− 18	20	45	7·5 ?	9·5 ?	..
138	U Sagittarii, . . .	18	24	49	− 19	12	33	7·0	8·3	6

…h of Max. G. M. T.	Epoch of Min. G. M. T.		Discoverer.		Remarks.
..		..	Birmingham,	1866.	Nova, 1866. *See* Notes.
..		..	Peters,	1880.	A. N., 2360.
July 21.		..	Argelander,	1855.	
..		..	Palisa,	1877.	
..		..	Auwers, Pogson,	1860.	Nova, 1860.
May 16.		..	Chacornac,	1853.	
Nov. 25.		..	Chacornac,	1854.	
..		..	Pogson,	1863.	
Sept. 2·9.		..	Hencke,	1860.	
..		..	C. H. F. Peters,	1880.	
..		..	Baxendell,	1857.	
..		..	Pogson,	1860.	
Mar. 4·4.		..	Pogson,	1854.	
..		..	Dunér,	1880.	
..		..	Pickering,	1881.	
June 12.		..	Schönfeld,	1856.	
May 3.		..	Hind,	1848.	Nova, 1848.
Oct. 21·7.		..	Pogson,	1853.	
..		..	Sir W. Herschel,	1795.	
.	1881.	Nov. 30·84.	Sawyer,	1881.	
..		..	Schmidt,	1869.	
..		..	J. Brunowski,	1604.	Nova, 1604.
Aug. 16·78.	1870.	Aug. 13·9.	Schmidt,	1866.	
July 10·659	1870.	July 7·5.	Schmidt,	1866.	
Mar. 12·4.	1867.	Dec. 25·9.	Argelander,	1857.	
Dec. 2.		..	Baxendell,	1860.	
..		..	Quirling,	1865.	
June 30·975	1870.	June 28·009	Schmidt,	1866.	

No.	Star.	R. A., 1880.			Decl., 1880.			Change of Magnitude.		Mean D
								Max.	Min.	
		H.	M.	S.	°	′	″			
139	T Aquilæ, ...	18	39	59	+ 8	37	12	8·8	9·5	Irre
140	R Scuti, ...	18	41	5	− 5	49	54	4·7–5·7	6·0–8·5	7
141	κ Pavonis, . . .	18	44	36	− 67	23	0	4·0	5.5	
142	β Lyræ, ...	18	45	39	+ 33	13	18	3·4	4·5	1
143	R (13) Lyræ, . . .	18	51	41	+ 43	47	30	4·3	4·6	4
144	S Coronæ Australis, .	18	53	4	− 37	6	51	9·8	11·5 ?	
145	R Coronæ Australis, .	18	53	50	− 37	6	48	10·5–11·5	< 12·5	
146	R Aquilæ, ...	19	0	36	+ 8	3	3	6·4–7·4	10·9–11·2	34
147	T Sagittarii, . . .	19	9	19	− 17	10	42	7·6–8·1	< 11	38
148	R Sagittarii, . . .	19	9	40	− 19	31	0	7·0–7·2	< 12	27
149	S Sagittarii, . . .	19	12	25	− 19	14	36	9·7–10·4	< 12·7	23
150	h′ (51) Sagittarii, .	19	28	44	− 24	58	48	5·3	6·7	
151	R Cygni, ...	19	33	36	+ 49	55	45	5·9–8·0	13	42
152	Nova Vulpeculæ, . .	19	42	45	+ 27	1	28	3	?	
153	S Vulpeculæ, . . .	19	43	29	+ 26	59	27	8·4–8·9	9·0–9·5	6
154	χ Cygni, ...	19	45	57	+ 32	36	42	4·0–6·0	12·8	40
155	η Aquilæ, ...	19	46	21	+ 0	41	57	3·5	4·7	7d 4h
156	S Cygni, ...	20	3	0	+ 57	38	27	8·8–9·5	< 13	32
157	R Capricorni, . . .	20	4	34	− 14	37	24	8·8–9·7	< 13	34
158	S Aquilæ, ...	20	6	6	+ 15	15	42	8·9–9·9	10·7–11·8	14
159	Y Sagittarii, . . .	20	7	26	− 22	20	31	..	..	14
160	R Sagittæ, . . .	20	8	36	+ 16	21	54	8·5–8·7	9·8–10·4	7
161	R Delphini, . . .	20	9	8	+ 8	43	36	7·6–8·5	12·8	28
162	P Cygni (34), . . .	20	13	21	+ 37	39	36	3·5	?	
163	U Cygni, ...	20	15	54	+ 47	31	0	7·7	< 11	46
164	R Cephei, ...	20	17	7	+ 88	46	15	5 ?	10 ?	
165	S Capricorni, . . .	20	34	42	− 19	25	18	9	11	
166	S Delphini, . . .	20	37	33	+ 16	39	30	8·4–8·6	10·4–11·1	27

ch of Max. G. M. T.	Epoch of Min. G. M. T.		Discoverer.		Remarks.
..		..	Winnecke,	1860.	
May 8·4.	1851.	April 3·3.	Pigott,	1795.	
..		..	Gould,	1872.	
..	1855.	Jan. 6. 14h 29m.	Goodricke,	1784.	Schönfeld gives the formula, $12^d\ 21^h\ 47^m\ 16^s{\cdot}837\,E + 0{\cdot}303977\,E^2 - 0{\cdot}0000149454\,E^3$.
April 11.	1869.	Mar. 27.	Baxendell,	1856.	
..		..	Schmidt,	1866.	
..		..	Schmidt,	1866.	
Feb. 10·7.	1864.	Sept. 27.	Argelander,	1856.	
Oct. 17.		..	Pogson,	1863.	
June 28.		..	Pogson,	1858.	
Nov. 20.		..	Pogson,	1860.	
..		..	Gould.		
June 16.		..	Pogson,	1852.	
..		..	Anthelm,	1670.	Nova, 1670.
Sept. 16·6.	1868.	Aug. 19·3.	Rogerson,	1837.	
Mar. 11.		..	G. Kirch,	1686.	
May 20. 14h 58m.	1848.	May 18. 5h 58m.	Pigott,	1784.	
Jan. 20.		..	Argelander,	1860.	
Oct. 3.		..	Hind,	1848.	
..	1869.	Oct. 2·7.	Baxendell,	1863.	
July, 1880.		..	C. H. F. Peters,	1880.	$n = 2$, or $n = 4$. A. N., 2360.
..	1868.	April 25.	Baxendell,	1859.	
July 13·6.		..	Schönfeld,	1859.	
..		..	Janson,	1600.	Nova, 1600.
Dec. 29.	1873.	May 11.	Knott,	1871.	
..		..	Pogson,	1856.	
..		..	Hind,	1854.	
Nov. 5.	1869.	July 28.	Baxendell,	1860.	

No.	Star.	R. A., 1880.			Decl., 1880.			Change of Magnitude.		Mean D
								Max.	Min.	
		H.	M.	S.	°	′	″			
167	T Delphini, . . .	20	39	48	+ 15	57	48	8·2–8·9	< 13	33
168	U Capricorni, . . .	20	41	30	– 15	13	18	10·2–10·8	< 13	20
169	T Cygni, ...	20	42	24	+ 33	56	6	5·5 ?	6 ?	
170	T Aquarii, ...	20	44	1	– 5	33	44	6·7–7·0	12·4–12·7	20
171	R Vulpeculæ, . . .	20	59	3	+ 23	20	36	7·5–8·5	12·5–13·0	13
172	W Capricorni, . . .	21	0	37	– 24	24	6	9–10	?	33
173	X Capricorni, . . .	21	1	41	– 21	49	51	11·5 ?	?	21
174	63 Cygni, ...	21	2	28	+ 47	10	0	4·7	6	± 5
175	T Cephei, ...	21	10	4	+ 68	0	8	6·4	9·8	40
176	T Capricorni, . . .	21	15	24	– 15	40	0	8·9–9·7	< 13	26
177	S Cephei, ...	21	36	42	+ 78	5	0	7·4–8·5	11·5	48
178	Nova Cygni, . . .	21	37	0	+ 42	17	44	3	?	
179	μ Cephei, ...	21	39	50	+ 58	13	48	4 ?	5 ?	Irreg
180	T Pegasi, ...	21	3	2	+ 11	57	6	8·8–9·3	< 12·5	36
181	δ Cephei, ...	22	24	43	+ 57	48	6	3·7	4·9	$5^d\,8^h\,47^m$
182	U Aquarii, ...	22	29	37	– 8	13	34	9·0	< 13·5	
183	S Aquarii, ...	22	50	41	– 20	59	0	7·7–9·1	< 11·5	27
184	β Pegasi, ...	22	57	58	+ 27	25	48	2·2	2·7	Irreg
185	R Pegasi, ...	23	0	37	+ 9	53	42	6·9–7·7	12 ?	38
186	S Pegasi, ...	23	14	29	+ 8	15	48	7·6	< 12·2	31
187	R Aquarii, ...	23	37	37	– 15	57	6	5·8–8·5	11 ?	38
188	T Ceti, ...	23	51	46	– 9	37	43	9·7 ?	?	?
189	R Cassiopeiæ, . . .	23	52	19	+ 50	43	6	4·8–6·8	< 12	427
190	U Cassiopeiæ, . . .	23	55	9	+ 59	41	12	6	9	?
					Added in the Press.					
34*a*	31 Orionis, . . .	5	23	38	– 1	11	13	4¾	< 6	?

…ch of Max. G. M. T.	Epoch of Min. G. M. T.		Discoverer.		Remarks.
Mar. 27.		..	Baxendell,	1863.	
Sept. 19.		..	Pogson,	1858.	
..		..	Schmidt,	1864.	
Oct. 16·9.	1870.	July 20.	Goldschmidt,	1861.	
Oct. 7·5.	1865.	Aug. 4·5.	Argelander,	1858.	
..		..	C. H. F. Peters,	1880.	A maximum in July, 1880. A. N., 2360.
..		..	C. H. F. Peters,	1880.	A maximum, end of Sept., 1880. A. N., 2360.
..		..	Espin,	1882.	
Jan. 11.		..	Ceraski,	1879.	
Nov. 13.		..	Hind,	1854.	
..	1864.	Oct. 15.	Hencke,	1858.	
..		..	Schmidt,	1876.	Nova, 1876.
..		..	Sir W. Herschel,	1782.	
Nov. 9.		..	Hind,	1863.	
Sept. 26. $10^h\ 50^m$.	1840.	Sept. 24. $20^h\ 14^m{\cdot}6$.	Goodricke,	1784.	
..		..	?		
Aug. 8.		..	Argelander,	1853.	
..		..	Schmidt,	1847.	
..		..	Hind,	1848.	
..		..	Marth.		
Sept. 4·7.		..	Harding,	1811.	
..		..	C. H. F. Peters,	1880.	A. N., 2360.
April 18·9.		..	Pogson,	1853.	Schönfeld gives the formula, $425{\cdot}9\,E - 0{\cdot}40\,E^2$.
..		..	Birmingham.		No. 658 of Birmingham's Catalogue.
..		..	Gould.		

NOTES.

1. T Cassiopeiæ.—Elements derived by Schönfeld from 3 maxima and 3 minima, combined with earlier observations. The increase from Minimum to Maximum lasts 246 days, and the decrease 190 days; both interrupted by minor fluctuations of light. The star is very red (Schmidt says "ausgezeichnet roth"). An 8 m. star follows, according to Schönfeld, 10^s and $0'\cdot5$ to the north.

2. R Andromedæ.—Schönfeld thinks that the period, at the date of earlier observations (1827, Oct. 14, by Bessel), was longer, probably about 409 days. At the maximum the light does not fluctuate much for a period of about 16 days; in 1850, this was even extended to 50 days, with perhaps a secondary minimum.

3. S Ceti.—Schönfeld finds the increase quicker than the decrease, and calls the star reddish (rothlich). The variability was discovered by comparisons with a star (No. 5 of "Catalogue of Suspected Variables") which was suspected of variation. Schönfeld observed a Maximum of S Ceti, 1874, Oct. 14, 7 m.; period about 333 days ("Ast. Nach.," No. 2065).

4. B Cassiopeiæ.—This wonderful star, which suddenly blazed out in November, 1572, was, according to Smyth ("Cel. Cycle," ii. p. 55), first seen by Schuler at Wittenburgh in August, 1572 (?). Tycho Brahé, whose name is usually associated with the star, first saw it on 11th November, 1572. It increased rapidly in brilliancy, until it surpassed Jupiter and equalled Venus in splendour, when it was visible in the daytime. This state of things was not, however, of long duration, as it gradually diminished, and in March, 1574, had completely disappeared. Its curious changes are thus described:— "As it decreased in size, so it varied in colour; at first its light was white and extremely bright; it then became yellowish, afterwards of a ruddy colour, and finished with a pale livid colour." The position given is that deduced by Argelander from Tycho Brahé's observations, and the place is situated about $1\frac{1}{2}^\circ$ north of, and a little preceding the star κ Cassiopeiæ. Within $1'$ of arc of the position assigned by Argelander, d'Arrest in 1865 observed a star of the 11th magnitude, which is of a reddish hue, and has, it is said, shown signs of fluctuations in its light. This small star, assumed to be the Nova, will be readily identified by means of a bright 9th magnitude, which is No. 22 of Argelander's Zone 60; it follows this 9 m. $29^s\cdot6$, and is south of it $10'\ 4''\cdot1$. Hind and Plummer's observations seem to show that the star is variable to the extent of nearly a magnitude. Sir J. Herschel thought it probable that the star was identical with "temporary" stars which are said to have been seen in the same

region of the heavens in the years 945 and 1264, and he therefore anticipated its return in 1872; but judging from the recorded dates, its period (if it has one) would seem to be *over* 300 years. As, however, 311 years have now (1883) elapsed, its appearance—if it is to re-appear—will not probably be much longer delayed. According to Schönfeld, the hypothesis of its identity with the Biblical star of the Magi has been supported by Cardanus, Chladni, and Klinkerfues; and the supposed length of its period, and the suddenness of its outburst in 1572, would seem to render such a theory very plausible.

5. T PISCIUM.—Schönfeld's observations show no regular period, and no remarkable colour. A very bright Maximum occurred 1872, December 1; and very faint Minima 1869, November 29, and 1870, December 30.

6. α CASSIOPEIÆ.—Schönfeld thinks the apparent light variation is usually within the errors of observation, and considers that the formula given by Argelander is very doubtful. Schmidt states that he can detect no trace of variation, although he has watched the star for several years. Heis gives the variation from 2·2 m. to 2·8 m.

7. U CEPHEI.—This very remarkable variable star is identical with DM 81°, 25. From his first observations, Ceraski inferred a period of about 10 days. Schmidt, however, by subsequent observations, reduced this to $4^d\ 23^h\ 35^m$; and from further observations at the Harvard College Observatory, U. S. A., it has been proved that the true period is only one half that given by Schmidt, or $2^d\ 11^h\ 47^m{\cdot}5$. The rapidity of its variation is very great, sometimes exceeding a magnitude in the course of an hour! The total variation exceeds two magnitudes. The star belongs to the Algol type, as it remains at its maximum brightness for the greater portion of its period. It then diminishes for a few hours, and as rapidly recovers its light. The star DM 81°, 30, 8·3 m. is within a few minutes of the variable. Knott finds that the period is subject to some irregularities, and that at alternate minima the star varies in brightness to the extent of about 0·3 m. (9·1 to 9·4). As two periods are nearly equal to 5 days, the alternate minima are observable at nearly the same hour in the evening. Thus Knott observed Minima in 1882, April 22, at $10^h\ 14^m{\cdot}3$, and April 27, $9^h\ 54^m{\cdot}3$. From photometric measurements at Harvard College, Professor Pickering finds a period of $2^d\ 11^h\ 49^m{\cdot}9$ E. At minimum the light is only 0·11 of the maximum light. The decrease and increase of light occupy about 6 hours. The light ceases to diminish about 1 hour before the minimum, and then remains constant for 1½ hours, when it begins rapily to increase. As in the case of Algol, Pickering considers that the variation of light is probably caused by an eclipsing satellite, and that in this case the eclipse is possibly a total one, the light at minimum being that emitted by

the satellite, which is self-luminous; or the observing body may be supposed to consist of a cloud of meteors, so scattered that about 0·11 of the light of the star can pass through them.

The star has been examined with the spectroscope at Lord Crawford's Observatory, and it was found that at the minimum the blue end of the spectrum faded, and the red end was intensified.

Knott has observed a small bluish star near the variable, and estimated its position 60°, and distance 10″.

8. S Cassiopeiæ.—Schönfeld finds the increase of light considerably quicker than the decrease. A star 9·6 m. follows 20ˢ and 2′ S.

9. S Piscium.—Reddish. Elements derived by Schönfeld from 6 good maxima. He notes an 11·12 n. star *nf*, and a 12 m. nearly south of the variable. At minimum, Schönfeld says the star completely disappears in his telescope.

10. R Sculptoris.—Discovered to be variable at Cordoba. Dr. Gould describes it as "one of the most brilliantly-coloured stars in the heavens," its colour being "an intense scarlet." The observations show a variation from 5·8 to 7·7 or lower, with a period of about 207 days, and a symmetrical light curve. Maxima occurred in December, 1872, and January, 1874 (two periods); and a Minimum, 1878, November 15 (mag. 7¾). It is No. 24 of Birmingham's Catalogue.

11. R Piscium.—Increase of light, according to Schönfeld, quicker than the decrease, in the proportion of 4 : 5, but with fluctuations. His observations between 1865 and 1869 give a period of only 337·5 days. He mentions an 11 m. star, *nf*, the variable.

12 S Arietis.—Schönfeld finds that all the observations indicate a period of 292 days, but that this does not agree with observations at Markree Castle, 1848, December 14; and by Winnecke, September and October, 1868. The last observations, if correct, would show that no regular period exists.

13. R Arietis.—Schönfeld says it has been well observed through thirty-one periods, and often at minimum. The elements also represent the observations of Bessel, 1828, November 26, 8 m., and 1832, December 15, 8·9 m.; and also the supposed invisibility of the star to Lalande, 1793, August 24. In some of the maxima, the light variation is very slow for some weeks.

14. ο (Mira) Ceti.—This is perhaps the most remarkable variable in either hemisphere. It varies from a bright 2 m. to about 9 m. in

a period of about 331 days. Schönfeld gives the following formula for the time of maximum:—

$$1866.\quad 11^{m}\,25^{d}\cdot4 + 331\cdot3363\,E + 10^{d}\cdot48 \sin\left(\frac{360^\circ}{11}E + 282^\circ\,45'\right)$$
$$+ 18^{d}\cdot16 \sin\left(\frac{45^\circ}{11}E + 31^\circ\,15'\right)$$
$$+ 33^{d}\cdot90 \sin\left(\frac{45^\circ}{22}E + 70^\circ\,5'\right)$$
$$+ 65^{d}\cdot31 \sin\left(\frac{15^\circ}{11}E + 179^\circ\,48'\right).$$

Argelander thought that the variations of brilliancy indicate a 40-year period. According to the same eminent authority, the mean brightness of Mira at maximum is 1½ steps brighter than γ Ceti. Heis finds it 2 steps brighter; and taking the brightness of γ Ceti as 31, he finds the average brilliancy of Mira at maximum, between 1840 and 1858, as 33·2 steps.

The mean duration of visibility to the naked eye is, according to Heis, 4 months; the interval from first visibility to maximum being at the mean 42·7 days, and from maximum to disappearance (to the naked eye) 73·7 days.

At minimum, Schmidt gives the magnitude 9·5 m.; but Schönfeld states that he has never seen it fainter than the companion (89°, 116″, 1831), or 9·1 m., and usually somewhat brighter. Heis states (AN. 1741) that at the maximum of 1868 (Nov. 7) Mira was fainter than he had seen it for 27 years—not brighter than λ Ceti. At the maximum of 1799 it was thought to be not little inferior to Aldebaran.

The following table shows the observed maxima of Mira Ceti since 1840:—

OBSERVED MAXIMA OF MIRA CETI.

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1840.	Sept. 29	Steps. 32·0	Heis.	
1841.	Aug. 27	32·0	„	
1842.	July 24	36·5	„	
1845.	Feb. 27	..	Schmidt.	
1846.	Feb. 4	..	„	
1846.	Dec. 20	41·0	Heis.	
1847.	Jan. 3	..	Schmidt.	

OBSERVED MAXIMA OF MIRA CETI—*continued.*

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1847.	Nov. 16	Steps. 23·0	Heis.	
1847.	Nov. 23	..	Schmidt.	
1848.	Oct. 12	34·0	Heis.	
1848.	Oct. 25	..	Schmidt.	
1849.	Oct. 2	..	,,	
,,	Oct. 4	28·5	Heis.	
1850.	Sept. 6	34·0	,,	
,,	Sept. 16	..	Schmidt.	
1851.	July 15	25·5	Heis.	
1855.	Mar. 16	..	Schmidt.	
1856.	Feb. 1	..	,,	
,,	Feb. 5	38·0	Heis.	
1857.	Jan. 18	34·5	,,	
,,	Jan. 24	..	Schmidt.	
1857.	Dec. 19	36·5	Masterman.	
,,	Dec. 24	..	,,	
,,	Dec. 21	..	Winnecke.	
,,	Dec. 28	38·0	Heis.	
1858.	Nov. 3	34·0	,,	
,,	Nov. 7	..	Winnecke.	
,,	Nov. 7	..	Schmidt.	
,,	Nov. 8	35·0	Masterman.	
1859.	Sept. 29	36·0	Heis.	
,,	Oct. 10	36·0	Masterman.	
,,	Oct. 12	2·7 m.	Auwers.	
,,	Oct. 13	..	Schmidt.	
,,	Oct. 15	..	Winnecke.	

OBSERVED MAXIMA OF MIRA CETI—*continued.*

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
		Steps.		
1860.	Sept. 9	..	Schmidt.	
„	Sept. 11	37·7	Heis.	
„	Sept. 15	37·0	Masterman.	
1861.	Aug. 2	..	Schmidt.	
„	Aug. 11	32·8	Masterman.	
1862.	July. 2	..	Schmidt.	
1863.	Feb. 11	..	„	A. N., 1410.
1865.	Mar. 19	..	„	
1866.	Feb. 24	..	„	One step brighter than α Ceti.
1867.	Jan. 16	..	„	
„	Jan. 18	..	Heis.	
1867.	Dec. 18	..	Schmidt.	
„	Dec. 17	..	Schönfeld.	2·7 mag.
„	Dec. 15	..	Heis.	
1868.	Nov. 7	= λ Ceti.	„	Fainter than Heis had seen it for 27 years.
„	Nov. 10	..	Schmidt.	Visible to naked eye for 86 days.
„	Nov. 11·5	5·0	Schönfeld.	
1869.	Sept. 27·7	..	Schmidt.	Ast. Nach., 1793.
„	Sept. 28	= γ Ceti.	Heis.	A. N., 1785.
„	Oct. 3	3·5 m.	Schönfeld.	
1870.	Aug. 27	..	Schmidt.	
1871.	July 16	..	Rock.	At Cordoba.
„	July 19	..	Davis.	At Cordoba.
„	July 22	3·9 or 4·0 m.	Schmidt.	
1872.	June 22	3 m.	Schmidt.	Only very little brighter than γ Ceti.
1873.	May 25	..	„	

OBSERVED MAXIMA OF MIRA CETI—*continued.*

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
		Steps.		
1875.	Feb. 27	..	Schmidt.	From comparisons with α Ceti.
,,	Mar. 1	..	,,	From comparisons with γ Ceti.
,,	Mar. 3	..	,,	From comparisons with α Piscium.
,,	Mar. 4	2·5 m.	Schönfeld.	
,,	Feb. 25	= α Ceti.	Gore.	Equal to α Ceti, but less than α Arietis.
1876.	Feb. 3·7	= α Piscium.	Schmidt.	From comparisons with α Piscium and γ and δ Ceti.
,,	Feb. 3	3 m.	Gore.	
1876.	Dec. 27	..	,,	From comparisons with α and γ Ceti.
1877.	Jan. 5·5	..	Schmidt.	About 1 step fainter than α Ceti.
,,	Jan. 9	..	Schwab.	4½ steps fainter than than α Ceti.
1877.	Dec. 11	28·2	Sawyer.	
,,	Dec. 10	..	Schwab.	
1878.	Oct. 14·9	..	Schmidt.	
,,	Oct. 16	..	Walisch.	
,,	Oct. 20	..	E. F. Sawyer.	3 or 4 steps brighter than γ Ceti.
1879.	Sept. 9	..	Schmidt.	
1881.	June 28–30	..	,,	
1882.	June 20	..	,,	

The following are some observed Minima of Mira Ceti :—

Year.	Date of Minimum.	Brightness.	Authority.	Remarks.
1863.	Feb. 11	..	Schmidt.	
1865.	Oct. 6	..	,,	Very little brighter than the companion, and distinctly red yellow.
1866.	Oct. 22	..	,,	
1873.	Jan. 17	8·7 mag.	Schönfeld.	
1873.	Dec. 30	8·9 ,,	,,	
1874.	Nov. 20	8·6 ,,	,,	
1875.	Oct. 30	..	Schmidt.	About the same brightness as the companion; at no time fainter.
1882.	Feb. 4	9·5	,,	

On 8th November, 1876, I found Mira about 9 m. and fiery red (3-inch refractor). A curious observation is mentioned with reference to Mira by Mr. E. F. Sawyer, the well-known American observer (*Observatory*, June, 1879). It is to the effect that Mr. W. K. Greely, of Boston, U. S., in August, 1871 (about two months before the maximum of that year), observed Mira as bright as a star of the second magnitude, and that a few nights afterwards it had faded to 4 m. or 5 m. As, however, Mr. Greely was not a regular observer, and had made no record of his observation in writing, the accuracy of the observation seems very doubtful. If true, however (as Mr. Sawyer seems to think), it was a very remarkable occurrence, as no irregularity of the kind has ever been previously observed in the case of Mira.

In several books on astronomy it is stated that Mira was invisible at the epoch of Maxima during the years 1672 to 1676; but this is incorrect, as it was long since (Ast. Nach. Modena, 1837) pointed out by Bianchi that the supposed invisibility of Mira was simply due to the fact that in those years the Maxima occurred at a time of year when the star was near the sun, and could not be observed.

On October 30, 1779, Sir W. Herschel observed Mira Ceti "of a middle size between Aldebaran and α Arietis"; and on November 2 its lustre was still increased" (*Phil. Trans.* 1780, p. 342).

15. S Persei.—According to Schönfeld, a Maximum occurred in December, 1873; but no approximation to correct Elements is yet possible. A 10·2 m. star, *nf.*

16. R Ceti.—According to Schönfeld, the period derived from 9 maxima is 167·65 days.

17. T Arietis.—Period derived by Schönfeld from 2 Maxima and 2 Minima. Variation slow.

18. ρ Persei.—Used as a comparison star for Algol, and in this way found to be variable by Schmidt, 1854. It seems to have no regular period, although Schmidt at first deduced a period of 33 days. Schönfeld observed a very bright phase (equal to or greater than δ Persei) on the following dates:—1854, October 30; 1866, November 28; 1867, February 2; 1869, March 9; and 1873, January 14.

19. β Persei (Algol).—This well-known variable star is now pure white, but seems to have changed in colour, as it was called red by the Persian astronomer, Al-Sufi, in the middle of the 10th century. Its variability was remarked by Montanari so early as 1667 or 1669, and, after him, by Maraldi, Kirch, and Palitzsch; but the true character of its variations was first determined by Goodricke in 1782. Its period, according to Schönfeld, is $2^d\ 20^h\ 48^m\ 53^s{\cdot}67$; but this seems to have diminished from $2^d\ 20^h\ 48^m\ 59^s{\cdot}5$, which it had in 1782. For the greater portion of its period it remains at a maximum of 2·2 m; and only during $9\frac{1}{4}$ hours does its light fluctuate, with a minimum of 3·7 m. about the middle of the period. The star has been especially studied by Argelander, who found that the period is not quite constant, but varies to a small extent. Schmidt finds that the brightness of Algol is equal to that of δ Persei about 47 minutes before and after minimum; to that of ϵ Persei about 62 minutes before and after the same; and to that of β Trianguli, 95 minutes before and after. From his observations between 1840 and 1875, Schmidt finds a period of $2^d\ 20^h\ 48^m\ 53^s{\cdot}6$.

Schönfeld states that to his eye the variation of Algol is included between the magnitudes 2·2 and 3·7.

From photometric measurements of the light of Algol at maximum and minimum, Professor Pickering finds that the diminution of light commences about 263 minutes before minimum, and recovers its normal brightness 337 minutes afterwards. The most rapid diminution takes place about 100 minutes before, and the most rapid increase about 100 minutes after, the minimum. Pickering believes that the decrease in the light of this star is due to a dark eclipsing satellite.

I observed a minimum of Algol during totality of the lunar eclipse of 23rd August, 1877.

20. R Persei.—From numerous observations through 21 periods, Schönfeld finds a period of 208·5 days. The Elements show an error sometimes amounting to 16 days. At minimum the star remains for about two months below 12 m., and sometimes descends even below 13 m.

21. λ TAURI.—A star of the Algol type, but not so well observed as Algol. The greater part of the light change is accomplished in a period of about 10 hours. The inequalities in the period are considerable, sometimes amounting to three hours.

22. T TAURI.—North following d'Arrest's variable nebula. Schönfeld can find no regular period, and remarks, with reference to its colour, "Nicht auffalend gefärbten."

23. R TAURI.—The period is, according to Schönfeld, subject to a variation of fifteen days; but still the elements correspond with the supposed invisibility of the star to Bessel, February 13, 1822, and an estimation by Bode (7 m.), February 6, 1798. The increase of light from 10 m. occupies about 37 days, and the decrease 47 days. Schönfeld says: "Im minimum nach Winnecke selbst für das 7½ zöllige Objectiv des Pulcowa-Heliometers unsichtbar." Hind and Goldschmidt call the star red; Winnecke, "trüb roth"; Secchi, "orangegelb"; and Schönfeld, "sehr roth."

24. S TAURI.—Period seems diminishing. Only for about 70 days of its period is the star brighter than 12 m., which renders it difficult to be observed.

25. R DORADUS.—Discovered to be variable by Thome at Cordoba. Dr. Gould says it is "excessively red."

26. V TAURI.—Schönfeld calls it "röthlich," and says, "die Veränderungen sind rasch"; and he thinks that a period of 171·8 days nearly as admissible as that given in the Catalogue. A 12·13 m. star follows the variable.

27. R ERIDANI.—Variation independently found by three observers at Cordoba; but Gould gives no period, owing to insufficiency of observations.

28. R ORIONIS.—According to Schonfeld, the increase of light from 10·2 m. occupies 70 days, and decrease 105 days, but both with marked fluctuations. Hind calls its colour "reddish"; Schönfeld, "stark röthlich"; and Secchi, "goldgelb."

29. ε AURIGÆ.—Schönfeld thinks there is no regular period, and says that the variation is often for a long period imperceptible.

Schmidt finds from his own observations, 1843 to 1875, that the star is irregularly variable, and only within narrow limits.

I observed ε to be almost exactly equal to η Aurigæ on the following dates:—1875, December 21; 1876, March 21; 1876, November 20. On 13th March, 1883, and 2nd April, 1883, I estimated its magnitude as 3·57 (from comparisons with η and ζ Aurigæ).

30. R Leporis.—Hind's "crimson star." Very difficult to observe on account of its colour, which Schönfeld calls "ungewöhnlich intensiv blutrothen." It is the *f* star of four nearly in a line: 16th March, 1876, with 3-inch refractor, I found it rather brighter than the furthest of the four, and much brighter than the next. The nearest star faint. Colour of R intense red.

Schönfeld gives the duration of increase of light as 230 days, and that of decrease 208 days.

31. S (64) Eridani.—Discovered to be variable by Gould from observations at Cordoba, where the estimates of magnitude varied from 4·8 to 5·7. It was rated 5½ and 6 by Lalande, and 6 m. by Argelander and Heis.

32. R Aurigæ.—Elements, according to Schönfeld, somewhat uncertain; 9 maxima give a period of 461·3 days, and 4 Minima 467·3 days. He says the light increase shows the rare phenomenon of a stand (*Stillstandes*) at the magnitude 9·2 to 9·0, which occurs about 114 days before the maximum, and lasts about 48 days, and even forms, in some years, a secondary maximum and minimum. On the average, the increase from 8·5 m. lasts 40 days, and the decrease 62 days. A 9 m. star *s. p.*

33. S Aurigæ.—Announced as variable by Dunér in 1881. The star was observed by him. 1878, September 29 and October 5, and its strong red colour and spectrum noted. On December 31, 1880, he missed the star, and on January 20, 1881, found it quite invisible in a 4-inch refractor, when it must have been fainter than 12 mag. About a month later, however, February 23, it was easily visible, and not much below 10·5 m. The fact of variability, M. Dunér considers certain. The star is recorded as 9·4 m. in the *Durchmusterung*, and is No. 108 of Birmingham's Catalogue of Red Stars, with the remark, "d'Arrest (17th Nov., 1868); sehr roth; 9·5".—*B.'s obs.*: "1876, March 13, not seen."

34. S Orionis.—A remarkable variable discovered by the Rev. T. W. Webb, 1870. Very red. Webb says:—"Centre of little triplet, 11, 11·5 m. in large triangle; sweep 6½ m. W from minute pair 10′ *n* of 42."

35 δ Orionis.—Schönfeld finds a small variation, but no regular period. Anwers found a period of 16·08 or 15·91 days with a minimum nearly in the middle of two maxima. Dr. Gould seems to think the variation doubtful (*Uranometria Argentina*, p. 329).

36. T Orionis.—This is Lalande 10492, and Dr. Gould says "it is certainly variable." It has been observed by Thome at Cordoba at

the magnitudes 5·7, 6·5, and 6·7. It was rated 7¼ m. by Hencke; 7¼ and 6¼ by Argelander; and it is 6·7 in the *Durchmusterung*. The star is red.

37. α ORIONIS.—Argelander found a period of 196 days; but later observations render this result doubtful.

38. η GEMINORUM.—From his own observations Schönfeld found for the brighter phase, small and not very regular fluctuations; but for the minimum a regular decrease and increase, the first about 6 weeks, the latter probably of somewhat longer duration. Schönfeld calls its colour "intensiv gelb." Schmidt, from his observations of two Maxima 1875, February 25, and September 23, finds a period of 210 days. From its proximity to μ Geminorum I have found its fluctuations of light occasionally very apparent.

39. T MONOCEROTIS.—Schönfeld finds tolerably regular variations from a maximum of 6·2 to a minimum of 7·6, but thinks that observations are probably influenced by the coincidence of its period with that of the lunar month. He calls its colour "goldgelb." Davis observed Maxima of this star at Cordoba 1872, April 24, and November 25 or 26; and Minima, 1872, April 14, and December 12. Bigelow observed Maxima in 1874, January 4 or 5, and February 1 and 28 (*Uranometria Argentina*, p. 331). Gould's period is 27·0054 days.

40. R MONOCEROTIS.—Near the comet like Nebula N 399. Schönfeld thinks that no regular period exists, and the minimum magnitude is uncertain.

41. S (15) MONOCEROTIS.—It is the chief star of the cluster H VIII. 5, and has two close companions of the 9th and 11th magnitudes. The period given in the Catalogue was found by Winnecke, and confirmed by Schönfeld; but other observers do not agree. Schönfeld calls its colour "gelblich"; Struve, "grün"; Dawes, "yellow."

42. R LYNCIS.—Identical with DM + 55°, 1154. With reference to its colour, Schönfeld says "Farbe anscheinend röthlich."

43. ζ GEMINORUM.—In 1844 Argelander found a period of $10^d\ 3^h\ 32^m{\cdot}3 \pm 6^m{\cdot}4$, but afterwards it increased. Schönfeld deduces the period given in the catalogue from Argelander's epoch, combined with observations by Schmidt and himself. He finds occasional inequalities up to $\frac{1}{16}$ of the period, but a greater portion of these are explicable by faults of observation. Argelander's light curve gives, from 6 years' observations, the decrease of light somewhat quicker than the increase.

Pickering considers it probable that the star is a surface of revolution, one side being about four-fifths of the brightness of the other.

44. R Geminorum.—According to Schönfeld, the light curve is very variable, especially at maximum, when the star often remains for a week without any perceptible change.

45. R Canis Minoris.—Another determination by Schönfeld gives a period of 329 days.

46. L^2 Puppis = Lacaille, 2691.—Discovered to be variable at Cordoba. Dr. Gould finds variation from 3·6 m. to 6·3 m., and infers a period of about 135 days, with a variation rapid at maximum, and comparatively slow near the minimum, which seems to occur about 6 days nearer to the preceding than the following maximum. Red in all stages, and remarkably so near the minimum. He gives the following dates of Maxima—1874, February 8, and June 25.

Dr. Gould suspects variation also in the neighbouring star L' Puppis.

47. U Monocerotis.—Discovered to be variable at Cordoba. The period was found to be about 46 days, with the minimum somewhat nearer to the preceding than the following maximum. Maxima were observed by Thome 1873, April 20 and June 5; and a Minimum on May 14. Maxima were observed by the Rev. T. E. Espin in 1883, on the following dates: January 28 and March 7, with secondary Maxima on February 14 and March 17; and Minima on February 10 and March 13, with secondary minima on February 20 and April 6. He deduces a period of about 31 days.

48. S Canis Minoris.—Schönfeld gives the formula:

$$\text{E p. E} = 1863\text{–}5\text{–}20{\cdot}1 + 333^{d}{\cdot}9\ \text{E} - 0^{d}{\cdot}4\ \text{E}^2,$$

and thinks that the period is diminishing. At maximum the light change is very slow for a week. A minimum of the star has not been observed. Schönfeld calls its colour "intensiv gelbroth."

49. T Canis Minoris.—From observations before 1865, Schönfeld finds a period of 322·1 days, but earlier observations require the longer period given in the Catalogue. Colour not marked. A 12·7 m. star *s.p.* and a 12·2 m. *s.f.* the variable.

50. S Geminorum.—Well observed since 1852. The variation is quick, according to Schönfeld, especially in the increase of light.

51. R Puppis.—Discovered to be variable at Cordoba. Dr. Gould assigns no period. It was rated 7 m. by Lacaille, and 5½ m. by Yarnell (1869, February, 27).

52. T GEMINORUM.—Schönfeld says the uniform period is sometimes in fault as much as 13·7 days. At the magnitude 9·5 there seems to be a strong retardation in the increase of light, but this is also variable. On the whole the increase seems quicker than the decrease.

53. S PUPPIS.—Discovered to be variable at Cordoba. It was called S by Lacaille, and this falls in with Argelander's nomenclature of the variable stars. It was rated 6 m. by Lacaille, and 7 m. by Taylor. Dr. Gould does not assign a period.

54. T PUPPIS.—Dr. Gould states that this star "has varied by not less than seven-tenths of a unit" during the progress of the Cordoba observations, "having increased from 7·0 m. or less in 1871 to 6·5 in 1875, and diminished again since then to 7·2." From this it would seem that the star probably belongs to Espin's Class III., viz.:—Variables having small variation of light with a period of several years. Dr. Gould says "it is decidedly red."

55. U GEMINORUM.—A very extraordinary variable, with a most irregular period. Sometimes it rises to a maximum with astonishing rapidity; in February, 1869, according to Schönfeld, it increased 3 magnitudes in 24 hours! From the maximum it diminishes with a slow and very variable light curve. The visibility at maximum usually lasts only 14 days; in 1858, November, not 10 days. At some of the maxima there is a secondary minimum. According to Schönfeld, the smallest interval observed between 2 maxima was 75 days, the greatest 617 days; and he thinks the period fluctuates between 70 and 150 days. At the Maximum of November, 1858, Baxendell found that the star "had a somewhat hazy or nebulous appearance." Colour not remarkable. A neighbouring star (No. 248 of "Catalogue of Suspected Variables") has been suspected of variation by Winnecke.

56. R CANCRI.—Period derived by Schönfeld from observations, 1850 to 1859; but he thinks the period is increasing, and that the early observations to 1833 require a period of 364 days. Increase of light quicker than the decrease. From the observations of 1830, the minimum falls about 125 days before the maximum. A 10 m. star, *sf.*

57. V CANCRI.—Schönfeld calls its colour "gelbroth." An 11 m. star follows, on the parallel, and a 10-11 m. *sf.*

58. U CANCRI.—Well observed since 1858 by Winnecke, and since 1865 by Schönfeld. According to the latter, the Elements fix the later maxima within 4 days. For a month before and after the maximum, the increase and decrease of light are nearly equal. At the minimum the star totally disappears in Schönfeld's telescope; and, according to Chacornac, even in a 9-inch refractor.

59. S Cancri.—The variation is of the type of Algol, but, according to Schönfeld, with a marked retardation of the increase of light at the brightness 9·6 m. The duration of decrease 8½ hours, and of increase 13 hours. The uniform period shows an outstanding fault from 20^m to 40^m, but this Schönfeld considers is also periodical. Argelander remarked that after the minimum the light begins to increase very rapidly, and he is inclined to suppose that its descent from the maximum is even still more rapid. Schmidt observed a Minimum (below 9 m.) 1877, March, $12^d\ 11^h\ 40^m$, Athens M.T; also in 1882, April 14, at $10^h{\cdot}1$ and $11^h{\cdot}3$, when it was only 11·7 m., fainter than he had ever seen it before. An 11 m. star precedes, nearly on the parallel.

60. S Hydræ.—The maxima are, according to Schönfeld, sometimes well marked, and sometimes for a week with a very slow variation of light. He calls its colour "röthlich gelb."

61. T Cancri.—Schönfeld says it is very difficult to observe on account of its extraordinary red colour (*ungemein roth*). The maximum occurs about 7 months before the minimum, but can hardly be determined with precision, owing to the small changes of light in this phase. Six observed minima are well represented by the Elements.

62. T Hydræ.—According to Schönfeld, the Elements given fix 11 maxima since 1858 within a few days.

63. R Carinæ.—Discovered to be variable at Cordoba. Dr. Gould finds it red in all its phases. The observed maxima give periods of 329, 306, and 326 days. Dr. Gould states that "the minimum appears to take place considerably more than half a period later than the maximum, and the variation of light at that time to be relatively slow. But while the magnitude is above 9, its change is quite rapid, being at the rate of one unit monthly; and the duration of the maximum is very brief." He gives the following dates of maxima:—1871, July 17; 1872, June 10; 1873, April 12; 1874, March 4 (*Uranometria Argentina*, p. 252). The star is Lacaille 3932 = 2551 Brisbane. It is included in Sir John Herschel's List of Red Stars (*Cape Obs.* p. 448, where it is described as a "very intense sanguine star, between scarlet and carmine red." From observations, 1880–1883, at Windsor, N. S. W., Tebbutt deduced a period of about 313 days, with Maxima about the following dates:—1880, December 16 (4·3 m.); 1881, October 21 (5·4 m.); 1882, September 2 (4·9 m.). And Minima about the following dates:—1880, July 5 (9·2 m.); 1881, June 8 (9·3 m.); 1882, March 27 (9·3 m.); and 1883, February 7 (9·3 m.); (*Mon. Not.*, R. A. S., November, 1883).

64. R LEONIS MINORIS.—The maxima, according to Schönfeld, are subject to irregularities up to 12 days. Increase of light much quicker than decrease. Increase from 9 m. lasts from 40 to 80 days.

65. R LEONIS.—This remarkable variable lies closely south of 19 Leonis, with which it has been sometimes confused, The period given in the Catalogue was calculated by Schönfeld from observations since 1818; and the Elements show irregularities, but no general lengthening or shortening of the period since the time of Bradley and T. Mayer. The minima are also affected with similar irregularities. The star is closely preceded by two stars about 8 m., which form, with the variable, an isosceles triangle. The star is considered by most observers to be very red. I found it about 7½ m., and fiery red, February 9, 1877, with 3-inch refractor.

The following Table shows observed Maxima of R Leonis since the year 1865:—

OBSERVED MAXIMA OF R. LEONIS.

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1865.	Feb. 27	6·4	Schönfeld.	Ast. Nach., 1628.
1865.	Mar. 18	..	Schmidt.	A. N., 1570. 331 days since last.
1866.	Jan. 15	6·3	,,	A. N., 1628.
1867.	Sept. 24	..	,,	Invisible in finder.
1869.	July 3	..	,,	A. N., 1805.
1870.	May 9	6·1	Schönfeld.	
1871.	Mar. 15	5·8	,,	
1872.	Jan. 24	5·5	,,	Estimation very good.
,,	Jan. 23·5	..	Schmidt.	A. N., 1932.
1872.	Dec. 6	..	,,	
,,	Dec. 1	5·9	Schönfeld.	A. N., 1988.
1875.	June 29	..	S. C. Chandler.	A. N., 2119.
1876.	May 7·7	..	Schmidt.	A. N., 2103.
,,	June 1·7	..	,,	Secondary maximum.
1876.	May 17·3	..	,,	

Observed Maxima of R Hydræ—*continued.*

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1877.	Mar. 6	5·2	Gore.	A little brighter than ν Leonis.
1877.	Mar. 14	..	Schmidt.	A. N., 2164.
1877.	Mar. 18	..	Schwab.	A. N., 2191.
1877.	Mar. 17·8	..	Schmidt.	A. N., 2240.
1878.	Jan. 18	7·0 m.	Schwab.	A. N., 2248.
1878.	Jan. 19·5	..	Schmidt.	A. N., 2240.
1881.	July 2	..	,,	
1882.	May 20	6·5	,,	
1883.	Mar. 19	5·4	Gore.	Slightly less than ν Leonis.
1884.	Jan. 27	6·5	Gore.	Slightly brighter than 19 Leonis.

Minima of R Leonis were observed on the following dates:—1867, March 1, 9·6 m. (Schönfeld); April 30 (Schmidt); 1868, March 7, 9·6 m. (Schmidt); and March 21; 1874, March 31, 9·4 m. (Schönfeld); 1875, February 13, 9·6 m. (Schönfeld); 1876, May 21·7 (Schmidt).

66. *l* Carinæ.—Discovered to be variable at Cordoba. Dr. Gould gives the following epochs of Maxima:—1871, July 31, and August 31; 1872, May 7. And of Minima:—1871, July 11, August 11, and September 12; 1872, April 17 (*Uranometria Argentina,* p. 253).

67. R. Velorum.—With reference to this star, Dr. Gould says:—"This has been seen by Mr. Thome to vary from the magnitude 6¼ to 7½, thus putting its variable character beyond question". He gives no period (*U. A.* p. 276).

68. R Antliæ.—Discovered to be variable at Cordoba. It was found near a Maximum, 1871, March 19; 1872, May 28, and 1874, May 29: and near a Minimum, 1873, April 28; 1874, June 14; and 1875, March 9. Dr. Gould does not assign a period (*U. A.* p. 295).

69. S Carinæ.—A variable discovered at Cordoba. Its period seems to be several months; but sufficient observations have not been obtained to determine the light curve. The star is reddish.

70. U HYDRÆ = LALANDE 20,556 = BIRMINGHAM 242.—Variation has been observed in this star by Birmingham, Gould, and Espin. Birmingham's estimates of magnitude, 1873–1876, vary from 4·5 to 6·5. The Cordoba determinations range from 4·3 to 6·1; and Dr. Gould says, "place its variability beyond all question." It was rated 6 m. by Hevelius; 5¼ by Lalande; 6·5 by Bessel; 7·5 m. by Lamont; and 6·5 by Argelander and Heis. According to the Cordoba observations, a Minimum occurred in the first half of 1871. Dr. Gould calls it "intensely orange red."

71. R URSÆ MAJORIS.—The elements found by Schönfeld represent the maxima generally well, and agree with the probable invisibility of the star to Lalande, 1790, March 15. Pogson, who has observed the star in minimum, fixes this 103 days before the maximum, and remarked (*Mon. Not.*, R. A. S., December, 1876) that the star rises with astonishing rapidity to maximum, but fades away very slowly. Schmidt observed a maximum (below 7 m.), 1876, June 17, and found the interval, from first visibility (13 mag.) to maximum, 28 days, and from maximum to disappearance, 112 days. Schönfeld calls its colour "röthlich," and Anwers, "blassroth."

72. η ARGUS.—This celebrated star is one of the most remarkable objects in the heavens, varying, as it has done, through all grades of brilliancy, from Sirius to a 7th magnitude star (!) It was observed by Halley as 4 m. in 1677; Lacaille, in 1751, rated it 2 m.; Burchell, 1811 to 1815, saw it 4 m. From 1822 to 1826, it was 2 m. In 1827, it was 1 m., and about equal to α Crucis. It shortly after diminished again to 2 m., and so remained till the years 1834 to 1837, when Sir J. Herschell, at the Cape of Good Hope, rated it 1·4 m. Suddenly, in 1838, it rose to a magnitude nearly equal to Canopus. After this it again faded, until 1843, when it was observed by Maclear to be brighter than Canopus, and almost rivalling Sirius in brilliancy. From that time its light has gradually diminished. It was 1 m. in 1856 (Abbott); 2·3 m. in 1858 (Powell); 3 m. in 1860 (Tebbutt); 4·2 m. in 1861 (Abbott); 5 m. in 1863 (Ellery); 6 m. in 1867 (Tebbutt). In 1874, it was observed 6·8 m. at Cordoba, and only 7·4 m. in November, 1878. Schönfeld considers that a regular period is very improbable, although a period of 46 years was suggested by Wolf, and a period of about 67 years by Loomis. The star is situated in a very remarkable nebula, in which some observers consider that remarkable changes have taken place since Sir J. Herschell examined it with his 20-feet reflector at the Cape. The spectroscope shows that the nebula consists of glowing gas, one of the constituents being hydrogen.

73. T CARINÆ.—Discovered to be variable by Thome at Cordoba, from observations in 1871–1874. The period has not been determined.

74. R Crateris.—Schönfeld finds, from very uncertain data, a period of 160 days. The star is of a remarkably red colour, and follows α Crateris 43^s, and 1'·2 to the south. A 9 m. precedes, and an 8·9 m. *sf.*

75. S Leonis.—Period derived by Schönfeld from observations since 1860. In 1870, the error was 15 days. Schönfeld thinks that perhaps the period may have been somewhat greater at first.

76. T Leonis.—Repeatedly observed in 1865, but invisible in 1863; and not seen, by Schönfeld, since 1866, with the exception of a trace, February, 1874.

77. X Virginis.—Seen by Schönfeld, March, 1873, and February, 1874, but nothing since known about the star. A 13 m. star closely follows, according to Peters. Schönfeld finds an 11 m. following 2^s, which he thinks identical with Peters' 13 m. star.

78. R Comæ.—Owing to the near coincidence of its period with that of the solar year, the star has become, since 1875, unfavourably situated for observation. It has been well observed by Winnecke only. Schönfeld calls its colour, "stark röthlich." A 7·8 star *np.*

79. T Virginis.—The elements, according to Schönfeld, represent the observed maxima well, especially those since 1861. The light curve is very little known; but the greater quickness of the increase from 11 m. is certain. Schönfeld mentions several small neighbouring stars. He calls the colour of the variable, "sehr roth."

80. R Corvi.—According to Schönfeld, the Elements of the Catalogue represent almost perfectly the observed maxima, 1868–1870, and those after 1874, June 18; but from observations by Lalande, 1796, April 23, and Argelander, 1851, March 8, the period given seems too large. Increase of light quicker than decrease. Two 8 m. stars and a 10 m. star in the immediate vicinity.

81. Z Virginis.—The variability of this star was discovered by M. M. Henry, of the Paris Observatory, in 1874, and has been regularly followed since 1876. According to M. P. Henry, a minimum took place in October, 1882 (*private letter*, June, 1883). The star is not in Lalande's Catalogue.

82. T. Ursæ Majoris.—The Elements given represent, according to Schönfeld, the maxima since 1860 to within about 10 days, but show an error of 50 days in the oldest observation, by Argelander, March 17, 1843. Schönfeld thinks that the period has decreased, and notes 2 Minima observed by him, 1873, February 18, and November 10.

83. R VIRGINIS—Frequently observed before 1832, and since 1844. The Elements given in the Catalogue show, according to Schönfeld, marked and regular deviations in the maxima, sometimes amounting to 17 days, and the minima show similar deviations to 14 days. He gives, from Argelander, the formula:—

$$\text{Max. Ep. } E = 1831.\ 9.\ 12{\cdot}92 + 145^{d}{\cdot}7242\ E$$
$$+ 8^{d}{\cdot}370 \sin (3^\circ\ 41'\ 17\ E + 310^\circ\ 15'\ 10'').$$

The light curve also shows irregularities.

84. R MUSCÆ.—A variable discovered at Cordoba. Its period is, according to Gould, not far from $21^{h}\,20^{m}$; magnitude at maximum about 6·6 and at minimum 7·3 or 7·4. The minima precede the maxima by 9 hours. Gould remarks that "its average brightness is so near the limit of ordinary visibility in a clear sky at Cordoba, that the small, regular fluctuations of its light place it every few hours alternately within or beyond this limit."

85. S URSÆ MAJORIS.—Schönfeld calls its colour "intensiv roth-gelb," and considers that a small increase in the period has occurred since an observation by Lalande, 1790, March 7. The light curve is very variable; and shortly before the maximum the increase of light is subject to a marked retardation. Pogson states (M. N., December, 1876) that the increase and decrease of light are more equal in duration than in other variables; but Schönfeld finds the former to vary between 77 and 125 days, and the latter between 104 and 152 days.

86. U VIRGINIS.—Some of the maxima calculated from the elements show a variation up to 23 days, according to Schönfeld; but some minima are represented within 3 days. In the neighbourhood of the maxima the light curve is very variable. A 10 m. star *np*.

87. W VIRGINIS.—Used as a comparison star for V Virginis, and thus found to be variable by Schönfeld, and nearly simultaneously by Auwers. Schönfeld considers the light changes very uniform; although Schmidt finds, from his observations in August, 1872, evidence of a double maximum.

88. V VIRGINIS.—Elements derived by Schönfeld from 5 observed maxima, since 1860, show deviations up to 10 days. Increase from 10 m., 35 days, with marked fluctuations; decrease 51 days, much more uniform. Colour, "stark gelbroth."

89. R HYDRÆ.—This remarkable variable star was first observed by Hevelius in April, 1662. It varies at the maximum from 4 to 5·5 m., and, at the minimum, descends to about the 10th magnitude. The period has, according to Schönfeld, diminished since the date of

its discovery, having been about 500 days in 1708, 487 days in 1785, 461 days in 1825, and 437 days in 1870, and it seems to be still decreasing. He gives the following formula, from Argelander, for the calculation of the time of Maximum:—

$$1815.\ 9.\ 2{\cdot}48 + 469{\cdot}3363\ E - 0^{d}{\cdot}44351\ E^{2} + 0^{d}{\cdot}001981\ E^{2}.$$

According to Schmidt, the minimum occurs about 200 days before the maximum.

Dr. Gould, at Cordoba, has studied the changes of this variable, and finds that the period is rapidly diminishing, the diminution amounting to more than 9 hours in each period, and that there is a symmetric perturbation which completes its cycle in 72 years. He gives the following formula of sines for the calculation of the time of maximum. counting from the beginning of the year 1875:—

$$T = 35^{d}{\cdot}6 + 434{\cdot}445n - 0{\cdot}37974n^{2} + 32^{d}{\cdot}0 \sin(5^{\circ}n + 10^{\circ})$$
$$+ 2^{d}{\cdot}6 \sin(10^{\circ}n + 324^{\circ}) + 6^{d}{\cdot}8 \sin(15n + 205^{\circ}).$$

This formula fixes a maximum for 1884, August 9.

Heis gives the minimum magnitude as 11 m. Smyth (Cel. Cycle) calls the star μ Hydræ; but this is a mistake, the real μ (42 Fl) being a 4 m. star a little south of a line joining λ Hydra with α Crateris.

The following are the observed Maxima of R Hydræ since the year 1853:—

Observed Maxima of R. Hydræ.

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1853.	Mar. 27	"sehr hell"	Winnecke.	Auwers. A. N., 1238.
,,	Mar. 30	..	Schmidt.	A. N., 1547.
1856.	Dec. 15	..	,,	,, ,,
1858.	Feb. 27·5	..	,,	A. N., 1410. Unsicher, zu Olmutz bestimmt.
1859.	May 20·5	..	,,	A. N., 1236. Genau, zu Athens bestimmt.
1859.	Last 3rd May	5·4	Auwers.	A. N., 1238.
1860.	Aug. 15	..	Schmidt.	4 or 5 steps fainter than γ Hydræ. A. N., 1300.
1863.	Jan. 19	..	,,	A. N., 1410.
1864.	April 14	..	,,	
1865.	July 4	..	,,	A. N., 1547. Period about 447·8 days.

OBSERVED MAXIMA OF R HYDRÆ—*continued.*

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1866.	Aug. 17–23	..	Schmidt.	A. N., 1627. "R. hatte zuletzt die 4. Grösse wenig schwächer als γ."
1869.	Feb. 8	4·1	Schönfeld.	A. N., 1817.
,,	Feb. 17	5·4	Schmidt.	A. N., 1805.
1870.	April 19	4·0	Schönfeld.	A. N., 1817.
1871.	July 3	= ψ Virginis	Schmidt.	
1873.	Nov. 19	..	,,	A. N., 1975.
1875.	Feb. 10	5 m.	Gore.	= ψ Hydræ (*S. Stel. Obj.*, p. 54).
1876.	April 12·5	..	Schmidt.	
1876.	April 12	5 m.	Gore.	About = ψ Hydræ.
1877.	June 13	4 m.	,,	Slightly brighter than α Corvi, but less than π Hydræ.
1877.	June 22	..	Schmidt.	In finder.
,,	June 24	..	,,	With naked eye.
1878.	Undetermined	..	,,	A. N., 2213.
,,	Aug. 11	5 m.	,,	In finder.
1882.	Mar. 6–9	..	Thome.	
1882.	Mar. 4–7	..	Stevens.	
1882.	Mar. 8	..	Schmidt.	
1883.	May 12	4·7	Espin.	
1883.	May 16	4·6	Gore.	

90. S VIRGINIS.—Elements derived from 9 maxima, 1857–1869, with a fault up to 6 days. Observations by Lalande, 1795, and Bessel, 1824, seem to show that the period is decreasing. The proportion of the increase of light to the decrease is very variable. According to an observation by Schönfeld, 1874, April 20, the minimum occurs about 119 days before the maximum. The star is No. 25039 of Lalande's Catalogue, and is marked 9 m. in Harding's Atlas (1822). Heis gives

the period 373·6 days, with a maximum on June 21, 1868. Schönfeld calls its colour "intensiv rothgelb"; Pogson, "vivid red"; and Auwers, "orange."

91. Y Virginis.—Observed by Schmidt, 1866, June 6, as a star of about 4½ m., and considerably brighter than the neighbouring star, 68 (i) Virginis. It afterwards gradually decreased in brightness.

It was rated 6½ m. by Lalande (25086), 8 m. by Piazzi, and 6·7 m. by Heis. It is 7 m. in Harding's Atlas.

Dr. Gould says that the Cordoba estimates (5·7 to 6·3) fully confirm the variability; and I have therefore designated the star Y Virginis, as suggested by him. (It is marked Z in Proctor's Atlas, Map 7.)

Schjellerup, in his translation of Al-Sufi's MS. (10th century), identifies the star (and correctly I think) with one numbered 19 of Virgo by Al-Sufi, and thus described:—"La 19e est la méridional du côté postérieur du quadrilatère, après *al-simâk* (Spica), s'inclinant vers le sud; elle est des moindres de la cinquième grandeur; Ptolémée la dit absolument de cinquième, mais elle est plus près de la sixième. . . . . Avec al-simâk et la 17e [76 Virginis] elle forme un triangle iscoscèle, cette étoile étant au sommet."

In 1879 Burnham made the interesting discovery that the star was a close double, the components of nearly equal magnitude, 6·2 and 6·5, at a distance of 0″·48, on an angle of 80°·4 for 1879. 4.

92. R. Centauri.—A variable discovered at Cordoba in 1871. The observations show that the light curve is irregular. A Maximum, 6·1 m. occurred about the middle of April, 1871. It sunk to a Minimum towards the end of that year, when it was invisible in a 4½-inch telescope, and reached a secondary Maximum of 6·7 m. about April 20, 1872. It then fell to a secondary Minimum of 8·7 m. about August 3, and rose again to 6·0 m. at the end of September, 1872. A Maximum of over 6·4 m. took place about August 3, 1877, and 6·1 about June 28, 1878. Dr. Gould thinks the observations may be "reconciled by supposing a full period of 525 days, with epoch of principal maximum, 1871, April 18; and two intermediate maxima following the principal one by 197 and 378 days respectively." This does not, however, agree with observations of 6¼ m. and 6 m., made 1874, June 25 and 26 (*Uranometria Argentina*, p. 268, 269).

93. T Bootis.—Only seen by Baxendell, 1860, April 9, as 9¾ m.; April 11, 10 m.; April 20, as 12·8 m.; April 23, invisible, and below 14 m. Schönfeld failed to see it in several trials since 1865. Place, according to Baxendell, $1^m 45^s$ preceding, and 11′ 30″ south of Arcturus. Schönfeld asks, "Ist der Stern eine kurz vor dem Erlöschen aufgefundene Nova gewesen?"

94. S BOOTIS.—Period derived by Schönfeld from 15 well-determined maxima since 1853. An observation by Lalande, 1790, February 21, is well represented by the Elements. The maximum of 1874 alone shows a difference of only 5·8 days.

95. R CAMELOPARDI.—According to Schönfeld, the observations show differences up to 24 days, and a very variable velocity of light change.

96. R BOOTIS.—According to Schönfeld, his Elements represent the maxima and minima well. Schmidt, however, makes the period 229 days, with a maximum, October 21, 1876.

97. δ LIBRÆ.—A variable of the type of Algol. The variation occupies about 12 hours, of which the decrease takes 5½ hours. The period is, according to Schönfeld, affected by inequalities, which Schmidt considers may be represented by a 9 years' cycle. Minima were observed by Schmidt in 1882, on May 17, $10^h\ 17^m{\cdot}8$, and June 14, $10^h\ 0^m{\cdot}8$, Athens M T. The error of Schönfeld's Ephemeris was in May, 1877, 32 minutes, and in 1878, 48 minutes. Schmidt's observations in 1878 show a well-marked increase in the period.

98. T TRIANGULI AUSTRALIS.—Variable according to Gould, with a "period which differs little from a mean solar day." He designates this star as T, reserving S for another star (No. 487 of Catalogue of Suspected Variables), which he believes will prove to be variable (*U. Argentina*, p. 260).

99. R TRIANGULI AUSTRALIS.—Gould finds the most probable period to be $3^d\ 9^m{\cdot}35$, the minimum preceding the maximum by about 48 hours. He considers the period to be nearly a constant one. Epochs of Maxima, 1871, July, $14^d\ 14^h$, and 1871, September, $13^d\ 12^h$; and of Minima, 1871, July, $12^d\ 14\frac{1}{2}^h$, 1871, September, $1^d\ 8\frac{1}{2}^h$, and 1872, July 29, $12^h\ 15^m$.

100. U CORONÆ.—A variable of the type of Algol. Decrease of light about 4½ hours; increase 5·2 hours. Some minima show deviations of 23 minutes from the mean period. Schmidt observed a Minimum, 1882, November 6, at $6^h{\cdot}6$.

101. S LIBRÆ.—Schönfeld gives periods of 187 days, with a maximum on 4th February, 1873; and 193 days, with a maximum on 17th June, 1874; the latter more probable, but both only approximate. He notes a 13 m. star *np*. and a 12 m. *nf*.

The variability of this star was also observed by Prof. C. H. F. Peters, 1868–1880 (Ast. Nach., 2360, No. 4). He notes two small stars forming an equilateral triangle (*gleichseitiges Dreieck*), with the variable. Peters deduces a period of only 98 days.

102. S Serpentis.—Schönfeld gives the following formula derived by Argelander:—

$$\text{Max. Ep. } E. = 1849.\ 5.\ 17{\cdot}39 + 362^{d}{\cdot}303\ E - 0{\cdot}188836\ E^2,$$

which represents well the earlier observations of the star up to 1860; but since that year deviations are shown, amounting in 1874 to 80 days. The uniform period of 361 days shows also considerable deviations from observation, amounting to 76 to 100 days too late in Harding's time, and for Lalande's time as much too early. The minimum occurs much nearer the following maximum than the preceding one. Schönfeld calls its colour "sehr roth," and notes an 11 m. star *np.*, and a 12·7 m. star *nf.*

103. S Coronæ.—The elements derived by Schönfeld from 13 maxima and 9 minima show irregular faults up to 20 days, but agree with the supposed invisibility of the star to Lalande and Bessel, 1794, April 30, and 1828, May 20.

104. T Libræ.—Discovered to be variable by C. H. F. Peters, from observations at Clinton (U.S.A.), 1877–1880. At times he found it completely invisible in very clear air, and deduces a period of 310 days, or perhaps half this (Ast. Nach., No. 2360).

105. U Libræ.—Discovered to be variable by C. H. F. Peters, from observations at Clinton, 1878–1880. He found it invisible in his telescope on the following dates:—1879, May 16; 1880, May 3, June 3 ("gänzlich unsichtbar"); July 10 ("unsichtbar, obgleich die Luft ausserordentlich schon"); and easily visible on the following dates, when he compared its brightness with neighbouring small stars:—1878, June 19, 27, and 28; 1879, June 18, July 9 ("ganz hell"), August 10; 1880, July 24, 27, and 31, and August 27 ("hell, und in die Augen fallend"). He derives a period of about 380 days, or perhaps half this (A. N., 2360).

106. Oe Arg. 14782 Libræ.—Discovered to be variable by C. H. F. Peters, at Clinton, U.S., from observations, 1878–1880. He found it invisible in his telescope on the following dates:—1879, June 18, July 8 ("sehr klare Luft"); 1880, August 27; and easily visible on the following dates, when he compared its brightness with small stars in the vicinity:—1878, June ("ungefähr 12. Gr."), July 5 (= Oe Arg. 14784), July 22 and 27, and August 3; 1879, May 17 and August 11; 1880, April 20, May 3 and 11, June 2 and 28, July 10, 24, and 31. He fixes a maximum for 1880, May 18, and deduces a period of $\frac{684}{n}$ days.

107. R Coronæ.—A very irregular variable, often remaining for a whole year at a maximum, or minimum with scarcely perceptible change. Frequently, however, a very quick light decrease takes

place. Periods of 323 days, 160 days, and smaller have been assigned; but none of them seem to represent the observations satisfactorily. In the years 1862 and 1863, according to Schmidt's observations, it remained of 6 mag. for a year and a-half! He observed a Maximum, 1867, November 6, scarcely 6 m. A very slow decrease followed to 1868, February 14. It then became quickly fainter, and on April 11 was not visible in the Finder. The colour was white, a little yellowish. From April 11 to November 12, 1868, it remained invisible in the Finder. On November 5 it was seen in the refractor as a doubtful star of 13 m.; and on February 8, 1869, he found it 13·12.

I found R visible to the naked eye in the Punjab, from April 14, 1877, to August 1, 1877; and on the following dates in Ireland:—1883, March 31 (5·7 m.), April 8; April 20 (5·8 m.); April 30; May 10 (6 m.).

108. R SERPENTIS.—Well observed since 1843. The period is affected with strong inequalities. The numbers in the Catalogue only apply to the epochs since 1865. According to Schönfeld, observations by d'Agelet near the Maximum, 1783, April 27 and 28, and the supposed invisibility of the star to Lalande, 1794, June 13, are well represented by the formula:—

$$\text{Ep. E.} = 1853.\ 10.\ 21{\cdot}0 + 396{\cdot}34\ E - 0{\cdot}01\ E^2 + 30^d \sin(9^\circ E + 144^\circ),$$

The star has not been observed at the minimum; but Schönfeld thinks that it does not descend below 12 m.

109. V CORONÆ.—This star is 8·5 m. in the *Dürchmusterung.* Birmingham could not see it, 1873, March 14 and 19, and April 20; and 1874, April 10. Ball also failed to see it, 1876, August 1. Dunér found it 10·5 m., April 21, 1878; but, on September 20, it was 7·8 m., and, on October 5, had risen to 7·5 m. Schmidt observed a Maximum, 1882, September 15·6, magnitude 8.

110. R LIBRÆ.—Very little observed, owing to the short duration of its visibility even in powerful telescopes. The Elements are derived from 3 observed maxima, 1860–1868; but Schönfeld thinks there may be a doubt whether the period of two years is not a multiple of the true period. A 12 m. star *s.p.*

111. T CORONÆ.—The wonderful "Blaze Star" discovered by Birmingham, 1866, May 12, 12^h, and shortly afterwards observed by several other observers in different parts of the world. When first seen it was equal in brightness to α Coronæ, or 2 m. It rapidly diminished, however, and on May 24 of the same year was only 8·5 m. It afterwards increased to 7·8 m. on October 16, 1866, but soon faded

again. It was soon found that the star was identical with DM + 26°, 2765, observed at Bonn by Schönfeld, May 18, 1855, and March 31, 1856, and estimated as 9·5 m. on both occasions. When near its maximum brightness, its light was examined by Dr. Huggins, with the spectroscope, which showed the bright lines of hydrogen in addition to the ordinary stellar spectrum. Some observers remarked that, when seen with the naked eye, it decidedly twinkled more than other stars near it, which rendered a correct estimate of its brightness very difficult.

The increase in the light of the star must have taken place very rapidly, as Schmidt of Athens stated that he was observing the vicinity on the same evening at 9½ hours, and that no star of even 5 m. could have escaped his notice.

Dr. Gould gives the following magnitudes of the star as observed by himself and S. C. Chandler (A.N. 1620):—

	Time.	Magnitude.
1866,—May 14,	11^h	2·9
,, ,, 15,	9	3·5
,, ,, 19,	9	5·8
,, ,, 19,	13	5·9
,, ,, 20,	9½	6·3
,, ,, 24,	9½	7·8
,, ,, 28,	10	8·9
,, ,, 31,	10	8·9
,, June 9, 11, 16, 20,		9·0
,, ,, 23,		9·1
,, July 2,		9·1
,, ,, 10,		9·2
,, ,, 31,		9·1
,, Aug. 6,		9·1

During the period 1866–1876, Schmidt has detected variations of light, which seemed to exhibit a certain regularity. He deduces from his observations a probable period of 94 days. This conclusion has been confirmed by Schönfeld. The star appears, therefore, to be an irregular variable, and not merely a "temporary" star.

It seems worth remarking that in the same constellation—not far from T—is another very irregular variable, R Coronæ (No. 107).

112. W Scorpii.—Discovered to be variable by C. H. F. Peters, from observations at Clinton, U. S. He found it invisible in his telescope on the following dates:—1873, June; 1879, May 21; 1880, April 20, May 3, May 11 ("bei sehr klarem Himmel"), June 2 and 6 ("bei schöner Luft"); but easily visible on many occasions in 1876, 1877, 1878, 1879, and 1880. He deduces a period of about 405 days ("oder ein aliquoter Theil davon, ½ or ¼"), with a maximum at the end of August, 1880.

113. R HERCULIS.—According to Schönfeld, the Elements show deviations up to 15 days; and since 1865 there seems to be a lengthening of the period.

114. V SCORPII.—A maximum occurred in the middle of March, 1879.

115. T SCORPII.—This is the Nova of 1860, discovered by Pogson, May 28, in the cluster 80 Messier, while he was searching for the variables R and S Scorpii, which are situated in the immediate vicinity. The star when first seen was 7 m., and bright enough to obscure the nebula. On June 10 the star had nearly disappeared, and the nebula again shone with great brilliancy, and with a condensed centre. Pogson's observations were confirmed by Auwers and Luther. It was stated by Pogson that he had examined the nebula on May 9, and found nothing remarkable; and, according to Schönfeld, on May 18 it presented its usual appearance in the Königsberg Heliometer. Some trace of the star seems to have been since seen by Schönfeld, who says—"Mir schien nur 1869, June 1, eine unsichere Spur desselbe vorhanden."

116. R SCORPII.—This star is near the cluster 80 Messier, and seems to have been seen by Admiral Smyth, who shows several stars in the field with 80 M, in a diagram (*Cel. Cycle*, p. 357). Schönfeld says the light curve is very variable, and the star has no particular colour. A maximum was observed by Schmidt (10 m.) 1876, September, 13·4.

117. S SCORPII.—Only 3¼′ distant from R Scorpii. The Elements, according to Schönfeld, represent the observed maxima within a few days. A 9·4 m. star *n.f.*

118. U SCORPII.—Discovered by Pogson 1863, May 20, as a 9 m. star; on May 28 it had sunk below 12 m., and on June 1 was invisible during a total eclipse of the moon. The star has not again been seen, although searched for by Schönfeld and Winnecke.

119. U HERCULIS.—The period given is the mean of two periods deduced by Schönfeld from 8 maxima, and 4 minima since 1870, but shows a fault up to 20 days; agreeing, however, with an observation by Bessel, 1825, June 13. Schönfeld calls its colour "intensiv rothgelb."

120. X SCORPII.—Discovered to be variable by C. H. F. Peters, at Clinton, U. S., from observations 1876–1880. He found the star invisible in his telescope on the following dates:—1879, June 23 and July 8, August 11 and 20; 1880, June 2, 30, and July 11, 13, 31,

and August 27; and easily seen on the following dates, when he compared its brightness with that of neighbouring small stars:—1876, July 11; 1880, April 20, May 3, 6, and 11. He assigns no period.

121. g (30) Herculis.—According to Schönfeld, the light changes are very irregular, with periods of 40 to 125 days.

122. T Ophiuchi.—Schönfeld could not find this star, although he searched for it on several occasions. Winnecke observed maxima, 1869, January 26; 1870, January 31 (doubtful); and 1874, February 6; and from these observations, Schönfeld finds a period of either 116·6 days or 359 days.

123. S Ophiuchi.—According to Schönfeld, the Elements show irregular deviatiations up to 9½ days. The light curve is very variable. The increase and decrease of light 14 days before and after the maximum nearly equal; afterwards the latter slower.

124. V Herculis.—This star was observed by Dunér as 8·3 m. in June, 1879. A year later it was about a magnitude fainter; and it afterwards steadily decreased to the 11th magnitude. There seems to be very little doubt of its variability to the extent of about 3 magnitudes. The star is not in Lalande's Catalogue.

123. R Ursæ Minoris.—Discovered by Professor Pickering, on September 13, 1881. Red, with a banded spectrum. Maximum towards the end of September. It precedes the star D M 72°, 735, $1^m 50^s{\cdot}5$, and is 10′ 18″ south of it.

126. S Herculis—The Elements, according to Schönfeld, show deviations of 16 days at minimum, and 25 days at maximum. A retardation in the increase of light usually takes place 1 to 2 months before the maximum, after which the decrease is very quick. A 9·7 m. star *sf.*, and a 6 m. *nf.* The latter star is 49 Flamsteed.

127. Nova Ophiuchi (1848).—When first noticed by Hind it was about 5 m. It afterwards rose to nearly 4 m., but very soon faded to 10 or 11 m. Hind is convinced that, up to April 3 or 5, no object of 9·5 m. or brighter was visible in its position. There are several small stars near the place of the Nova. This curious object has become very faint of late years. In 1856, it was 10 m.; 1866, 12 m.; and in 1874 and 1875, not above 13 m.

128. R Ophiuchi.—According to Schönfeld, a period of 302·1 days would also represent the observations, including the first, by Lamont, June 22, and July 9, 1847.

129. α HERCULIS.—Very irregular, and, according to Schönfeld, often scarcely perceptibly variable. The period, according to Argelander, varies from 26 to 103 days; according to Baxendell, up to 111 days; according to Heis, 184·9 days, with 2 maxima and 2 minima. Westphal, in 1817, thought that the observations might be represented by even a period of 7 days.

Schmidt observed Maxima in 1882, February 20, June 24, and September 19; and Minima, 1882, April 7, August 6, and November 3.

130. U OPHIUCHI.—Discovered by E. F. Sawyer, in 1881, to be a variable of the type of Algol. It is D M 1°, 3408, and Lalande 31384. The period was at first supposed to be $5^d\ 5^h\ 38^m{\cdot}6$, but was afterwards found by S. C. Chandler to be only $20^h\ 7^m\ 41^s{\cdot}6$, being the shortest period known. It remains at its maximum brightness (6·0 or 6·1) for 16 hours; and all the variations from maximum to minimum, and back again to maximum, are accomplished in about four hours. Schjellerup, in his Catalogue (Copenhagen: 1864), already pointed out its probable variability; and he estimated it 7·7 in a clear sky, 1863, June 9. The magnitudes given by other observers are very discordant; and variation of magnitude from 6·0 to 6·5 were observed in 1871 by Davis at Cordoba.

131. u (68 Fl.) HERCULIS.—Regularly observed by Schmidt since 1869. Period, according to Schönfeld, 37 to 40 days, with numerous anomalies, especially at the minimum, when fluctuations of a few steps take place in periods of 24 to 26 hours, and last about 3 days. Schmidt gives extremes of 4 m. and 6 m.; but these are seldom reached.

132. NOVA OPHIUCHI.—Kepler's great new star, which suddenly blazed out in October, 1604. When first seen it was white, and exceeded in brilliancy Mars, Jupiter, and was even thought to rival Venus in splendour! It gradually diminished, and in six months was not equal in lustre to Saturn. In March, 1606, it had entirely disappeared. The position given is that deduced by Schönfeld from the observations of David Fabricius. There does not, however, seem to be the same amount of certainty with reference to its exact position as in the case of Tycho Brahé's star in Cassiopeiæ. The nearest star is one of 12 m., a little *sf.* Chacornac, however, in 1861, mapped a star of 10 m. about 2′ *preceding* the spot. This star would seem to have since disappeared, as it was missed by some observers in 1871 and 1872. Winnecke, however, observed, in 1875 a 12 m. star very near the place occupied by Chacornac's star. It has been stated that no star was discernible in this position, with 7 inches aperture, on several occasions in 1872–74. It would, therefore, appear that a variable star exists close to the place of the Nova; and its variability is, of course, evidence in favour of its identity with Kepler's star. About 6′ following the calculated position of the Nova is a 8·9 m. star—Oeltzen, 16872. This star is again followed by two fainter stars, forming with it a rough isosceles triangle.

133. X (3) Sagittarii.—The Elements show well-marked inequalities, but the mean period given is, according to Schönfeld, certain to within $0^d{\cdot}0005$.

134. W (γ') Sagittarii.—The observations show marked irregularities in the period, the deviations sometimes amounting to $\frac{1}{10}$th of the period; the proportional length of the increase and decrease of light also varying.

135. T Herculis.—Elements derived by Schönfeld from observations of 35 periods, and show deviations up to 10 days, which have partly a regular course. A 10 m. star *np.*

136. T Serpentis.—This star lies *sf.* the coarse cluster, H. VIII. 72. The Elements show deviations to 15 days; but Schönfeld thinks that the period may have become longer since 1866. Increase of light from 10 m. about 51 days, and the decrease 54 days, both with marked fluctuations. An 11·12 m. star *nf.*

137. V Sagittarii.—Variation since 1870, according to Schönfeld's observations, only trifling, and not periodical.

138. U Sagittarii.—Elements derived by Schönfeld from 142 maxima and 152 minima observed by Schmidt, which nearly agree with his own since 1870. There appear to be inequalities up to $\frac{1}{8}$th of a period. A star 8·6 m. *nf.*

139. T Aquilæ.—From numerous observations since 1868, Schönfeld can find no regular period.

140. R Scuti.—Schmidt and Schönfeld find that bright and faint minima usually alternate. From 18 certain determinations of minima, Schönfeld finds the correction of minimum epoch for E = 94 (1869, July) in the mean + 4 days.

141. κ Pavonis. A southern variable discoverod at Cordoba, from observations by Thome in 1872 and 1873. The mean period of 9·1 days is the same for the minima as the maxima. According to Gould, the period is subject to considerable fluctuations; and the position of the minimum also varies, although always later than midway between the maxima. He gives the following dates of maxima and minima:—

Maxima—1871, December 31; 1872, October 6; 1873, July 26.

Minima—1871, November 29; 1872, December 25; 1873, July 3.

142. β LYRÆ.—Elements derived by Schönfeld from Argelander's observations, 1840–1859, combined with those of Goodricke, Westphal, and Schwerd. This star has 2 maxima of 3·4 m. and 2 minima, one 3·9 m., and one (the chief minimum) of 4·5 m. Schönfeld finds, from a comparison of Argelander's light curve with his own, the following correction for the Elements:—

Cor. Ep. 291 (1865, April 20) + $0^h\ 53^m{\cdot}2 \pm 17^m{\cdot}49$.
" " 450 (1870, Dec. 2) + $2^h\ 53^m{\cdot}6 \pm 21^m{\cdot}30$.

Smaller irregularities in the epochs and brightness also occur.

143. R (13) LYRÆ.—Variation, according to Schönfeld, small, but certain. Elements derived from a few observations by Baxendell and Schmidt.

144. S CORONA AUSTRALIS.—From six years' observations Schmidt found a period of 6·11713 days. With the addition of a seventh year Schönfield derives the Elements:—

Ep. E. Min. 1870. 3. 26·17; Max. 1870. 3. 29·41 + $6^d{\cdot}1130$ E;

and from another calculation of the epoch:—

Ep. E. Min. 1870. 3. 29·79; Max. 1870. 4. 2·04 + $6^d{\cdot}2170$ E.

He thinks that even a period of 6·0 days or 6·33 days not quite excluded. The great southern declination of the star renders it, even at Athens, difficult to be observed.

145. R CORONA AUSTRALIS.—In connexion with a small nebula, also variable according to Schmidt. From the available data Schönfeld cannot find satisfactory Elements. With reference to this star, Schmidt says (A N 1613):—"Nebel *n* und der westlich in ihm stehende Stern *x* fahren fort veranderlich zu sein, wie es scheint unabhängig von einander. Wenigstens fur *x* Kann die Periode nicht kleiner als 25 Tage sein."

146. R AQUILÆ.—Elements derived by Schönfield from 8 maxima and 17 complete periods. These show marked faults up to 9½ days. The light curve is very variable, especially at the maximum and during the first 2 months of the decrease. The increase from 9–10 m. to 7–8 m. is often extraordinarily quick. Schonfeld calls its colour "ausgezeichnet roth." A 9·6 m. star *sp.*, and a 10·6 m. *np.*

147. T SAGITTARII.—The Elements derived by Schönfeld represent well the earlier observations up to 1849. Increase from 9–10 m. and 9 m. very slow; afterwards quicker.

148. R SAGITTARII.—Elements derived by Schönfeld from 3 certain maxima since 1866, and represent well all the observations. An 11·3 m. star *sp.*, and a 10·8 m. star *np*, the variable.

149. S Sagittarii.—Elements derived by Schönfeld from a few maxima since 1866, and show a difference of about 10 days. Schiaparelli considers that this star is identical with a "temporary" star which appeared in the year 1690.

150. *h'* (51) Sagittarii.—Discovered to be variable at Cordoba. Very numerous estimates showed a variation from 5·3 to 6·7 m.; but Dr. Gould suspects that the extremes may be even still wider. He has not been able to determine the period. The star was rated 6 m. by Lacaille, Lalande, and Piazzi; but Heis rated it 5–4 (= 4·7), and Behrmann 6–5 (5·7). It is not in Argelander's *Uranometria*.

151. R Cygni.—This star lies closely *sf.* θ Cygni. The Elements are derived by Schönfeld from 8 maxima since 1854, and show irregular faults up to 16 days, but agree with earlier observations. According to Pogson, the minimum occurs 155 days before the maximum. A 9 m. star *nf.*

152. Nova Vulpeculæ.—The Nova of 1670, discovered by Anthelm as 3 m. The position given has been calculated by Schönfeld from the observations of Hevelius and Picard. Within one minute of arc of this place a small star was observed at Greenwich (Position for 1875:—R A 19^h 42^m $32^s{\cdot}78$, N P D 62° 59′ 15″·4), and there is a suspicion of variability in this star within narrow limits. In August, 1872, it was exactly equal to a star which follows it $12^s{\cdot}5$ in R. A., and 4′·9 to the north; while in November, 1874, it was certainly fainter by half a magnitude (*Nature*, June, 1877).

With reference to the star 11 Vulpeculæ of Flamsteed, supposed to be identical with Anthelm's Nova, Baily could not find that such a star exists, but says, "Under the presumption that it may be a variable and not a *lost* star, I have preserved its recorded position, with a view of inducing astronomers to look out for it from time to time. . . . The observation in Lalande's *Hist. Celeste*, p. 25, evidently does not belong to this star." The position given by Baily for 11 Vulpeculæ is, for 1690—

R. A. 293° 43′; Decl. 26° 35′.

According to Hind (*Ast. Soc. Mon. Not.* Vol. xxi., 1860–61) the suspicious star precedes Lalande 37730 by 25 seconds in R. A., and is 23′·1 south of it. He says that to his eye "there is a hazy ill-defined appearance about it, which is not perceptible in other stars in the same field of view. Mr. Talmage received the same impression; and I may add that Mr. Baxendell, who has examined it with Mr. Worthington's reflector, observed that no adjustment of focus would bring the star up to a sharp focus on June 1st." Hind also remarks that the variable star S Vulpeculæ, which follows the star above alluded to ($43^s{\cdot}6$ and 2′·11″ S.), has been shown to have no proper

motion to account for the difference of position since 1670. "From the fixity of position during eight years it may be inferred that the Greenwich variable is distinct from Anthelm's."

153. S VULPECULÆ.—This star *follows* the preceding. Elements derived by Schönfeld from 63 periods show deviations up to 12 days; but these deviations follow a regular course, and indicate a shortening of the period. Baxendell suspects a neighbouring fainter star to be also variable.

154. χ CYGNI.—A remarkable variable, Bayer's χ Cygni, sometimes confused with 17 (Fl.) Cygni, to which Flamsteed affixed the letter χ by mistake, the variable—which is the true χ—having been faint at the date of Flamsteed's observation. According to Schönfeld, the observations cannot be represented by a uniform period. The Elements given in the Catalogue give the maxima in 1687–1738, and since 1863 too early, and in 1747–1758 and 1821–1862 too late; but on the whole the observations seem to show a small lengthening of the period. From the observations of late years the minimum occurs approximately 185 days before the maximum. At some maxima the star is barely visible to the naked eye. There are numerous faint stars in the vicinity. The following are dates of observed maxima since 1862:—

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1862.	June 25	..	Schmidt.	*Ast. Nach.*, 1376.
1865.	Nov. 19	..	Schönfeld.	A. N., 1628.
„	Nov. 23	..	Schmidt.	
1867.	Jan. 22	..	Heis.	Visible to naked eye for about 2¼ months. A. N., 1642.
1869.	April 22	5·2 m.	Schönfeld.	Both good. A. N., 1857.
1870.	June 4	5·2	„	
„	June 5	..	Schmidt.	
1871.	July 13·2	..	„	A. N., 1871.
„	July 15	4·6	Schönfeld.	A. N., 1907. About = ϕ Cygni.
1872.	Aug. 24	5·1	„	A. N., 1992.
„	Aug. 26	..	Schmidt.	A. N., 1969.

Year.	Date of Maximum.	Brightness.	Authority.	Remarks.
1873.	Oct. 5	..	Schmidt.	A. N., 1975.
,,	Oct. 5	..	Schönfeld.	A. N., 1922. "Well estimated."
1874.	Nov. 8	6 m.	Schmidt.	A. N., 2031.
,,	Nov. 9	4·7 m.	Schönfeld.	A. N., 2065.
1877.	Jan. 29·4	..	Schmidt.	A. N., 2121.
1878.	Mar. 14	5 m.	,,	A. N., 2213.
1879.	April 25·6	..	,,	
1880.	May 30	..	,,	
1881.	July 17	..	,,	
,,	July 14	..	Sawyer.	
1882.	Sept. 1·5	..	Schmidt.	
1883.	Oct. 5	4·8	Gage.	
1883.	Oct. 19	4·9	Gore.	

Schmidt observed a minimum of χ Cygni, October 11, 1878.

155. η Aquilæ.—According to Schönfeld, the uniform period given in the Catalogue does not quite suffice to represent the observations, which show marked deviations, amounting to over 6½ hours in 1873. These variations are confirmed by Schmidt's observations.

156. S Cygni.—The period given would, according to Schönfeld, represent the observations well within the probable errors of observation. An 8·9 m. star *n.f.*

157. R Capricorni. — The Elements show great irregularities, sometimes amounting to as much as 30 days. Schönfeld mentions a 13 m. star, nearly due-north of the variable, distance 20″.

158. S Aquilæ.—Elements derived by Schönfeld from 10 minima, observed by him since 1865. Light curve very variable. Schönfeld has observed a maximum nearly midway between two minima, others much nearer the following maximum, which is sometimes even replaced by a secondary minimum. A 9 m. star *s.f.*

159. Y SAGITTARII.—Entered in Chacornac's Chart, 1852–3, but not seen by Peters on the following dates:—1868, June 24; 1870, June 6; 1873, June 24; 1875, July 1 and 2, and August 9; 1877, June 17 and July 4; 1878, June 30; 1879, June 23 and July 12. He found it, however, visible on the following dates, and compared its brightness with that of neighbouring small stars:—1868, July 12; 1871, June 20; 1872, June 29; 1876, July 15 and 19; 1877, July 6 ("sehr schöne Luft, gerade sichtbar"); and 1880, June 18.

160. R SAGITTÆ.—This star has a double minimum. From Schönfeld's observations, the intervals of the phases about the chief minimum (at the mean 10 m.) are as follows:—

First Max. . .	8·6 m. . .	14·4 days.
Second Min. . .	9·0 . .	34·5 ,,
Second Max. . .	8·8 . .	45·3 ,,

with marked irregularities of brightness, especially near the first minimum. The period seems to have decreased up to 1870–71, and since then become greater. Schonfeld finds that the following formula would reduce the deviations of all the epochs under 2·9 days:—

$$\text{Min Ep. E} = 1868{\cdot}4{\cdot}25{\cdot}968 + 70^{d}{\cdot}467\ \text{E} - 2^{d}{\cdot}463 \sin\ (4^\circ\ 30'\ \text{E}).$$

161. R DELPHINI.—Observed by Hencke, August 6, 1851, as 9 m., and considered to be a new planet; and not further observed until July, 1859, when it was found to be a variable by Schönfeld. The Elements represent 5 good maxima since 1865 within 7 days, and all the earlier observations. Schönfeld has not succeeded in observing a minimum. A 12 m. star *s.p.*

162. P (34) CYGNI.—The so-called Nova of 1600, which was remarkably variable (up to about 3 mag.) in the beginning of the 17th century; but since about 1677, it has been almost always recorded in transit observations of 5 m. or 5½. The only notable exception is an observation by Bessel, 1825, September 14, when it was rated 6·7. It is marked in Bayer's Maps with the letter P. Kepler's observations of the star in 1602 agree closely with the place of 34 Cygni, according to modern observations. According to Kepler, it remained of the third magnitude for many years, and then disappeared. It was again observed by Dominique Cassini in 1655, and gradually brightened during 5 years, until it reached the 3rd magnitude, and afterwards diminished. In 1677, 1682, and 1715, it is recorded of the 6th magnitude; and there is no further record of any marked increase of brightness. Pigott assumed a period of about 18 years, but this seems very doubtful.

I have made the following observations of the relative brightness of 34 Cygni, compared with neighbouring stars:—

November 9, 1876, . .	34 brighter than 36 Cygni, but less than 29 Cygni.
August 1, 1877, . .	34 brighter than 36, and very slightly brighter than 29.
April 19, 1878, . . .	Brighter than 36, but slightly less than 29. About equal to 28 Cygni.
November 12, 1882, .	34 equal to 28 Cygni.

163. U Cygni.—Schönfeld says that his observations of this star do not agree with those of Knott. A blue star 8·9 m. *nf.*, which Birmingham believes to be slightly variable.

164. R Cephei.—Identified by Pogson, with 24 Hevelius Cephei (5 m.), and Schönfeld and Johnson consider this identification correct. In 1859, it was, according to Schönfeld, only 9·10 m., and since 1865 varying between 8 m. and 8·6 m., with a period somewhat shorter than a year, and a maximum in November or December. From the recorded observations, Pogson deduced a period of 73 years. In August and September, 1838, Farley saw it bluish, and considerably less than λ Ursæ Minoris. Johnson observed in 1840, August 22 and September 1, with the meridian circle of the Radcliffe Observatory, and noted it "10th mag., scarcely visible.' In September, 1847, he estimated it 8·5 m., and it was easy to observe. In the 3 following years, it was only seen very faint, between the 9th and 10th magnitudes.

In Carrington's Redhill Catalogue, it is No. 3138, and rated 8·5 m. Its position for 1855 is given as R. A. $20^h\ 34^m\ 37^s{\cdot}1$, and N. P. D. $1^\circ\ 18'\ 59''{\cdot}1$ (with the note "Proper Motion"), agreeing closely with Schönfeld's place. In the Radcliffe Catalogue for 1860, it is 8·3 m. (No. 2000), and its position for 1860 R. A. $20^h\ 31^m\ 1^s{\cdot}52$, and N. P. D. $1^\circ\ 17'\ 58''{\cdot}2$. In the Washington Catalogue for 1871, R Cephii seems to be No. 8960 (= B A C 7184). The position given agrees closely with Carrington's place for his No. 3138. In *Mon. Notices R. A. S.* for May, 1856, it is stated that R Cephei has been confounded by Lalande and other astronomers with λ Ursæ Minoris; but Pogson has shown it to be in reality identical with Groombridge 3402. (In Groombridge's Catalogue, No. 3402, it is rated 5 m.; and its position for 1810 is given R. A. $21^h\ 2^m\ 26^s{\cdot}48$, N. P. D. $1^\circ\ 29'\ 10''{\cdot}3$.)

By comparisons with the star Carrington 3082 (south of it) on 15th March, 1880, and 30th March, 1881, I estimated the magnitude of R Cephii at 8·5. It was estimated about the same by the Rev. T. E. Espin, on April 6, 1880 (*private letter*).

165. S Capricorni.—Not in Schönfeld's Catalogue, but given by Chambers in his Handbook of Descriptive Astronomy (p. 584, 3rd edition).

166. S Delphini.—Elements derived by Schönfeld from his observations of minima since 1865; but they show a marked fault up to 21 days, which seems to show a shortening of the period. The irregularities of the maxima are still greater, the star sometimes remaining for a month without any well-marked variation of light. An 8·3 m. star *np.*

167. T Delphini.—The Elements derived by Schönfeld fix 5 observed maxima since 1865 within 4½ days; but in 1867 the deviation was about $-27\cdot8$ days. From these observations, Schönfeld also finds the Elements:—

$$\text{Ep. E.} = 1869.\ 4.\ 1 + 330^{d}\cdot7\ \text{E}.$$

Increase from 10 m. on the average 28 days, and decrease 49 days. An 11 m. star *np.* and a 10 m. *nf.* Schönfeld calls its colour "stark gelbroth."

168. U Capricorni.—According to Schönfeld, the light variation near the maximum is partly quick, and partly for a week long very trifling.

169. T Cygni.—From his own observations, Schönfeld finds a certain epoch for the maximum scarcely determinable; but at the minimum (November to June), the star seems to vary much quicker. From Schmidt's data, Schönfeld derives the following formula:—

$$\text{Ep. E. Min. } 1869.\ 12.\ 1,\ \text{Max. } 1870.\ 6.\ 8 + 365^{d}\ \text{E}.$$

170. T Aquarii (= Lalande 40196).—The Elements derived by Schönfeld fix 4 minima since 1865 within 4 days, but six maxima only with a regular fault up to 16 days. A period of 202·05 days would represent an observation by Lalande, 1794, July 15, 7·8 m., but is not in agreement with observations by Bessel, 1822, August 19, and Lamont, 1844, October 3.

171. R Vulpeculæ.—Frequently observed. The probable uniform period is, according to Schönfeld, 136·8 days; but this gives a regular fault up to 20 days, which he considers would be reduced below 7 days by the Elements:—

$$137\cdot5\ \text{E} - 0\cdot06\ \text{E}^2.$$

A 9–10 m. star *nf.*

172. W Capricorni.—Discovered to be variable by C. H. F. Peters at Clinton, U. S. A., from observations, 1878–1880. He found the star invisible in his telescope on the following dates:—1878, August

3; 1880, September 24, and November 23; and easily visible on the following dates, when he compared its brightness with that of neighbouring small stars:—1878, August 22, 29, September 2, 19, and 21, and October 1 and 16 (ganz hell); 1879, July 15, September 11 and 20, and October 6; 1880, July 15 and 18, August 16, 26, and September 10. He deduces a period of 326 days, with a maximum in the latter half of July, 1880 (A N 2360).

173. X Capricorni.—Discovered to be variable by Prof. Peters at Clinton, U. S. A., from observations, 1871–1880. He found it invisible in his telescope on the following date:—1871, July 12. And visible on the following dates, when he compared its brightness with small stars in the vicinity:—1871, July 16 ("bemerkt wie ein sehr schwaches Pünktchen"); 1872, July 2 and 12 ("kaum sichtbar"); 1875, August 25; 1876, July 16 ("hell"), 21, and 26, September 8, November 5 ("nür eben sichtbar sehr schöne Luft"); 1877, November 7; 1878, August 2, 29, September 2, 19, 21, October 1, 16 ("sehr schwach"); 1879, July 15, September 11, 20, October 6 ("sehr klein"); 1880, July 15, August 16, 26, September 10, 24 ("hell"), and November 23.

He deduces a period of 217 days, with a Maximum about the end of September, 1880.

174. 63 Cygni.—A variable of long period, discovered by the Rev. T. E. Espin, who assigns a variation of 4·7 m. ± to 6·0 m. ± with a period of about 5 years from minimum to minimum. In January, 1878, it was about 6·0 m. With the exception of some slight fluctuations, it increased in light till, in November, 1881, its magnitude was 4·7. On May 4, 1882, it was as bright; but on August 8, it seemed to have lost light; and on August 11, 1882, it was about 5·0 m. On January 15, 1883, it had fallen to 5·6 m., since which it has again increased in light (*Mon. Not. R. A. S.*, March, 1883).

I observed this star to increase in light from 5·0 m. on 4th March, 1883, to 4·8 m. on 10th May, 1883. On 13th August, 1883, I estimated it 5·0 m. (57 Cygni = 5·3 m.); 17th August, 1883, 5·0 m.; 4th September, 1883, 5·0 m.; 6th December, 5·0 m.; 30th December, 5·0 m.

175. T Cephei.—This star is D M 67°, 1291. The following maxima and minima were observed by Knott:—

Min., 1881, June 18, mag. 9·5.
Max., 1882, January 13, mag. 6·4.
Min., 1882, July 23, mag. 9·8.

The interval between the minima is 400 days.

A maximum was observed by Schmidt, 1882, January 11, mag. 6·7.

M. Ceraski's comparison stars are :—

R. A. 1855.	Decln. 1855.	Mag.
$21^h\ 5^m\ 45^s$	$+67°\ 40'$	7·0
21 7 33	67 54	8·7
21 10 15	69 51	6·8
21 12 11	69 27	6·5

176. T CAPRICORNI.—The Elements, according to Schönfeld, well represent 8 maxima since 1855, and an observation at Markree Castle, 1850, August 5. A 9 m. *np*.

177. S. CEPHEI.—According to Schönfeld, only regularly observed by Winnecke, from whose observations of minima the following Elements would result :—

$$\text{Ep. E.} = 1866.\ 2.\ 12{\cdot}4 + 487^d{\cdot}1\ \text{E}.$$

But other observations would seem to require the period given in the Catalogue. Winnecke finds that the maxima occur approximately 240 days after the minima.

178. NOVA CYGNI (1876).—Discovered by Schmidt at Athens, near ρ Cygni, on the evening of November 24, 1876, when it was 3 m., and rather brighter than η Pegasi. It rapidly decreased, however, and on November 30 had descended to the 5th magnitude. The following estimates of magnitude, determined by Schmidt, will show how rapidly it faded :—

Nov. 24,	3·0	magnitude.	
„ 25,	3·1	„	
„ 26,	3·1	„	
„ 27,	3·2	„	
„ 28,	3·8	„	
„ 29,	4·7	„	
„ 30,	5·0	„	
Dec. 1,	5.2	„	
„ 2,	5·4	„	
„ 3,	5·6	„	
„ 4,	5·8	„	
„ 5,	5·9	„	
„ 7,	6·3	„	
„ 8,	6·5	„	
„ 9,	6·6	„	
„ 10,	6·5	„	
„ 11,	6·7	„	
„ 12,	6·7	„	
„ 13,	6·8	„	
„ 14,	6·9	„	(hardly visible to the naked eye).
„ 15,	7·0	„	(visible so for the last time).

On the evening of its discovery, Schmidt considered the star to be a strong golden yellow, and that afterwards it remained of a deep yellow, but at no time was it so ruddy as the neighbouring 75 Cygni. Schmidt observed the constellation Cygnus on several occasions between November 1 and 20, and is certain that no star of even 5 m. could have escaped his notice, so that the star must have blazed out very suddenly. Between November 20 and 24 the weather was cloudy, so the exact time of its appearance is unknown. The star was examined with the spectroscope a few days after its discovery; and its spectrum showed bright lines similar to those of T Coronæ in 1866. One of the bright lines is supposed to be identical with the line 1474 Kirchoff, visible in the spectrum of the solar corona. The other bright lines were identified by M. Cornu, of the Paris Observatory, with some of the lines of hydrogen, sodium, and magnesium.

The star would seem to be quite new, as there is no star in any of the catalogues in the position of the Nova. The nearest registered star is one about 9 m., which is found in the Bonn observations. When the star had faded to 7 m., it was considered by some observers to be colourless, whereas by others it was thought to be decidedly orange. I could see no trace of colour in the star with a 3-inch refractor on January 13th, 1877 (when first seen in the Punjab), but it had then faded to the 8th magnitude. On February 7th, 1877, I estimated it 9 m.

The place of the Nova is situated south of, and a little *f.*, 75 Cygni. A little south of it is Lalande 42383. (8 m). In September, 1877, the star was spectroscopically examined with a 15-inch refractor by Lord Lindsay, who found "the light coming from it almost entirely monochromatic, the star appearing exactly the same as when looked at without the spectroscope, the direct prism having no effect on it." He considers "that there is little doubt but that this star has changed into a planetary nebula of small angular diameter." On September 3rd the mag. was 10·5; "faint blue near another star of same size rather red."

Schmidt, with the Athens refractor, has observed three small stars near the variable, with the following differences of right ascension and declination:—

13 m. . . .	y = Nova − 1^s·0 . .	Nova − 45″
13	z = ,, − 1·6 . .	,, − 81
12·5 . . .	x = ,, + 4·6 . .	,, + 20

For details of the spectrum of this curious object see *Mon. Notices* of R. A. S., Vol. XXXVIII., No. 4, Feb., 1878.

Dr. Vogel considers that the theory of the star having changed into a planetary nebula is inadmissible, the wave length of the stellar line being 4990 ± 10, whereas the wave lengths of the three nebulous lines are 5003, 4957, and 4861, of which the second is the most charac-

teristic; and this line was not seen at all when the spectrum was very bright. [See note at end].

At Lord Lindsay's observatory the position of the Nova with respect to above 50 closely adjacent stars has been micrometrically determined.

179. μ CEPHEI.—Sir W. Herschel's "garnet star." It seems to have been observed by Ptolemy. Argelander considered its variability beyond doubt, but Schönfeld thinks it questionable. He gives, however, the following Elements :—

Ep. E. Min. 1855.10.15·6, Max. 1856.6.20·1 + 431^d·786 E

as probably an approximation to the truth. Owing to its very red colour, it is difficult of observation.

From comparisons with ϵ, λ and 10 Cephei, I estimated the magnitude of μ Cephei as follows :—

April 6th, 1878, ...	4·7 m.
Jan. 12th, 1882, ...	4·8 ,,
Mar. 17th, 1883, ...	4·3 ,,
April 8th, 1883, ...	4·9 ,,
April 20th, 1883, ...	4·8 ,,
Sept. 4th, 1883, ...	5.1 ,,
Dec. 30th, 1883, ...	4·7 ,,

180. T PEGASI.—Argelander found that the observations from 1822 to 1864 would be well represented by a period of 374 days; but Schönfeld finds that, neglecting observations before 1864, the data since that time are represented by the period given in the Catalogue within about 5 days, and show a small lengthening of the period since 1864. The star seems to remain for a long time at 11 m., especially at the increase.

181. δ CEPHEI.—According to Schönfeld the period and light curve show considerable irregularities, the calculated times of maxima and minima sometimes requiring a correction of over an hour. Argelander's light curve shows a check in the decrease of light 16 to 24 hours after the maximum, and Schönfeld's observations show the same, but of shorter duration.

182. U AQUARII.—Though long since notified as a variable star, it seems to have been little observed. It was invisible on November 9th, 1874. It was estimated 9 m. at Markree on October 27th, 1848, and it was of the same brightness in August, 1855. It is not in Lalande's Catalogue.

183. S Aquarii.—Elements derived by Schönfeld from observations of 4 maxima and 18 complete periods give the period 280·4 days, with deviations up to 10 days. Correcting the period with reference to an observation by Lalande, 1798, Oct. 22, this deviation would be increased to 18 days at the maximum of 1873, Oct. 8th.

184. β Pegasi.—Variation irregular, according to Schönfeld, and often for a long time scarcely perceptible. Argelander found as an approximation—

$$\text{Ep. E. Min. } 1851.\ 9.\ 23{\cdot}3,\ \text{Max. } 1851.\ 10.\ 14{\cdot}6 + 41^{d}{\cdot}079\ \text{E.}$$

But Schönfeld says this is not confirmed by observation, the period being more probably an irregular one between the limits of 30 and 50 days.

185. R Pegasi.—According to Schönfeld, the observations cannot be represented by a constant period. The Elements

$$\text{Max. Ep. E.} = 1858.\ 3.\ 17{\cdot}1 + 379^{d}{\cdot}48\ \text{E}$$

would, however, well represent the observations from 1848 to 1867. The period given in the Catalogue is deduced by Schönfeld from 9 certain maxima and 21 complete periods, but shows a fault up to 30 days, and does not agree with earlier observations.

186. S Pegasi.—Period derived by Schönfeld from observations in 1872 and 1873, and a maximum, 1874, middle of July. He gives the approximate Elements. .—

$$\text{Max. Ep. E.} = 1873.\ 9.\ 4 + 316^{d\cdot}\ \text{E.}$$

187. R Aquarii.—From the earlier observations of the star Schönfeld derives a period of 392 days; but from Argelander's observations and his own, he finds 391 days, the period having probably diminished. He thinks, however, that the period may have even changed to 380 days or 405 days; but neither of these will agree with Argelander's observations, 1843–1848. He suggests that Argelander's observed maxima, in these years, may have been only secondary; and his own observations show signs of such secondary maxima. Schönfeld calls its colour "sehr roth."

The period of this star has lately been discussed by S. C. Chandler, Jun. (*Science Observer*, Oct., 1877); and he concludes that "instead of a uniform period, we must assume a variable one, with a mean value of 387·4 days, which runs through the cycle of its irregularities

in 44·4 or 41·86 single periods." He gives the following formula for the calculation of the time of Maximum:—

$$1843,\ \text{Sept. } 20^{d}\cdot26 + 387\cdot394\ E + 33\cdot9\ \sin\ (8^{\circ}\cdot6\ E + 170^{\circ}\ 20'),$$

which, however, he considers must be further corrected by future observations.

The following Maxima were observed by Schmidt (*Ast. Nach.* Nos. 2171 and 2240):—

Mean max., 1877, Sept. 14—Period since last Max. = 386 days.
" " 1878, Oct. 5—Period, 385·6 days.

188. T CETI.—Observed as 9·7 m. by Peters, 1879, September 11 and 12, while making observations for the minor planet Chryseïs (No. 202), but missed by him, 1880, September 2 and 23. On the following dates he again found it visible, and compared its brightness with some neighbouring small stars:—1880, October 31, November 5, 9, and 26.

189. R CASSIOPEIÆ.—From 12 observed maxima, Schönfeld considers that the period is certainly decreasing. Assuming a constant period he gives the Elements:—

$$\text{Max. Ep. E.} = 1866.\ 4.\ 7\cdot9 + 427^{d}\cdot6\ E\ ;$$

but this increases the greatest deviation from 9 to 17 days. A 10 m. star *sp*. the variable.

190. U CASSIOPEIÆ.—This is No. 658 of Birmingham's Catalogue of Red Stars. Birmingham's Estimates of Magnitudes, 1873 to 1877, vary from 7 to 8½ or 9. Webb rated it 9·7, 1874, January 10, and 9 m., January 12. Birmingham says:—" This star is certainly variable, as Secchi also has remarked." It has a blue star near it, similar to U Cygni.

NOTES ADDED IN THE PRESS.

13. R ARIETIS.—From a discussion of the observations of maxima and minima since 1859, Baxendell deduces a period from the maxima of 186·71 days (Epoch, 1866, September, 1·3), and from the minima, 186·63 days (Epoch, 1870, January, 2·3), and finds that the mean interval from minimum to maximum is 87·7 days, and from maximum to minimum 99 days.

29. ε AURIGÆ.—I have further observed this star as follows:—October 3, 1883, 3·37 m.; March 31, 1884, 3·27 m.

30. R LEPORIS.—Minima were first observed by E. F. Sawyer on January 25, 1882, and March 15, 1883, magnitude, 6·9.

34*a*. 31 ORIONIS.—Has been observed at Cordoba at the magnitudes 4¾ and below 6, and "in almost all the intermediate stages" (*Uranometria Argentina*, p. 328). It is No. 110 of Birmingham's Catalogue of Red Stars. I have observed the star as follows:—

1875, Dec. 16,	. . . .	6·0 magnitude.
1876, Jan. 19,	. . . .	5·8 ,,
1884, Feb. 22,	. . . .	5·3 ,,
,, Mar. 13,	. . . .	5·5 ,,
,, April 1,	. . . .	5·2 ,,
,, ,, 7,	. . . .	5·0 ,,
,, ,, 12,	. . . .	4·9 ,,

This star is certainly variable.

36. T ORIONIS.—The proximity of this star to λ Orionis renders it rather difficult of observation. I have observed it as follows:—

1884, Feb. 12,	. . . .	6·3 magnitude.
,, ,, 14,	. . . .	6·4 ,,
,, ,, 22,	. . . .	6·2 ,,
,, March 3,	. . . .	6·2 ,,
,, ,, 13,	. . . .	6·0 ,,
,, ,, 15,	. . . .	6·2 ,,
,, ,, 31,	. . . .	6·2 ,,
,, April 11,	. . . .	6·2 ,,

38. η GEMINORUM.—This star was discovered to be a close and difficult double by Burnham, with 12-inch refractor; the companion about 9 m., and about 1″ distant.

44. R GEMINORUM.—Secchi found a wonderful spectrum at maximum, with bright lines.

47. U MONOCEROTIS—The star is Lalande 14658 (8 m.). It is 8 m. in Harding's Atlas.

53. S PUPPIS.—I estimated this star 8 m. in March 1876.

65. R LEONIS.—Minimum, 1882, November 6, 9 m., Schmidt.

94. S BOOTIS.—Schmidt observed a maximum (8 mag.), Sept. 26, 1876.

107. R CORONÆ.—I have made the following further observations of this remarkable variable :—August 13, 1883, R small with binocular, about 7 m.; August 17, 1883, not seen with binocular, moonlight; March 17, 1884, R brighter than 6 m.; March 20, about the same; April 2, about 5·8 m.; April 7, R bright with binocular, moonlight; April 19, bright, no moon; May 12, R about 5·9 m.; May 18, about 5·9 m.

109. V CORONÆ.—The observations seem to indicate a period of about 290 ± days.

124. V HERCULIS.—It is said to be white at maximum and ruddy at minimum. (*Cel. Objects*, p. 321.)

142. β LYRÆ.—According to Pickering, if the light at either maximum be represented by 100, that of the two minima will be 55·8 and 64·7. (*Observatory*, October, 1881.)

174. 63 CYGNI.—Taking Peirce's measured magnitudes of the comparison stars, the observed magnitudes in the notes should be raised from 5·0 to 4·7. The star seems to me very reddish, but it is not in Birmingham's Catalogue.

175. T CEPHEI.—I observed this star at or about a maximum on March 22, 1884, when I estimated it 6·4 m.

178. NOVA CYGNI.—Backhouse observed a line in the spectrum of this star at about 4960, which agrees fairly well in position with the second nebular line. This, however, rapidly faded out, and the spectrum was ultimately reduced to a line whose wave length was 5022. Ward found the star only 16 m. in October, 1881. (*Knowledge*, Jan. 4, 1884). Schmidt looked for it repeatedly in 1882, but without success.

179. μ CEPHEI.—This star was measured at Oxford with the "wedge" photometer 4·53 (1883·011), ε Cephei on the same date being measured 4·78.

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(*Continued from page* ii. *of this Cover.*)

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[*For continuation of List of Publications, see page* iii. *of this Cover.*]

XV.—NOTES ON THE PLANTS OF SOME OF THE MOUNTAIN RANGES of IRELAND. By HENRY CHICHESTER HART, B.A.

[Read, May 26, 1884.]

I BEG to lay before the Royal Irish Academy a report on the botany of several of the mountain groups of Ireland, having been given a grant for that purpose.

I.

In the summer of 1883 I visited Brandon in Kerry, the Commeraghs in Waterford, Mount Leinster and Blackstairs in Carlow, the Mourne Mountains in Down, and their Carlingford continuation in Louth, Ben Bradagh, Sawel, and Dart in Derry, and some others in other counties whose exploration I have not yet completed.

Brandon is situated in the promontory and barony of Corckaguiny, more usually called the Dingle promontory, and which, with the outlying Blasquet Islands, is the most western portion of Ireland. Of the botany of these islands my friend Mr. Barrington has given an account.

"This barony," says Smith, in his *History of Kerry*, "is a peninsula of about 24 Irish miles in length and 8 in breadth; it is washed on the south side by the bay of Dingle or Castlemaine, and on the north by Tralee Bay; and answers to Cambden's general description of this county, 'that it shoots like a little tongue into the sea roaring on both sides of it.'"

The area of this mountainous peninsula is 138,996 acres, or about one-eighth part of the county Kerry. It possesses, perhaps, a greater variety of attractions and less accommodation for visitors than any other part of Ireland. There are to be seen here the most perfect Irish antiquities, whether Pagan or early Christian. Its geology has been called the key to the geological structure of Ireland. Its peculiar position as the extreme west of Europe, its loneliness, the primitive simplicity of its inhabitants, the grandeur of its scenery, its exquisitely bracing atmosphere, and the many interesting features of its natural history, place it in the fore-front ground for a summer's labours in many fields of research.

Its botany is especially interesting, and has drawn thither almost all who have paid attention to the subject in Ireland. Nevertheless, in consequence, perhaps, of the lack of roads and hotel accommodation, it required and still requires further examination. Having regard to Moore and More's *Cybele Hibernica*, of the twelve districts into which Ireland is divided, that which includes Kerry (District 1) has the fewest gaps in the list of Irish plants found therein, excepting District 12 on the north-east. This is in great measure owing to the fact that botanists, like other human beings, were attracted

by the Kerry scenery, and thereby this county became better searched. I was able, however, to add several to the list for the district, and others to the county Kerry flora.

The peninsula lies along an east and west axis, in S. lat. 52° 1′ to 52° 20′, and W. long. 9° 48′ to 10° 40′. It is crossed by two mountain ranges running north and south—the Brandon range from Brandon Point to Dingle, with an elevation of 3127 feet, and the Cahirconree range, nearer to Tralee, reaching 2796 feet at Baurtregaum. Of this latter group I have given an account in the *Journal of Botany* for 1883. These two chief ranges are about 18 miles apart, and the intervening space is of a wildly-irregular and picturesque description, consisting of numerous isolated heights, glens, and tarns, with one considerable cluster of mountains rising to 2713 feet at Benooskey.

The coast line is for the most part precipitous; the western and southern portion from Cloghane to Anniscaul almost entirely so. The rock formation of Brandon belongs to the Silurian group, and is chiefly composed of grits, slates, and sandstones. The remainder of the extreme promontory consists of an upper series of rocks of a similar nature, known to geologists as the Dingle beds. The inner or eastern part of the peninsula is formed of Lower Carboniferous rocks, and here limestone is more frequently met with. The main part of the barony is unreclaimed, and cultivation is chiefly to be met with along the coast margin on the northern and south-western shores and in the valleys.

There have been several dubious and unverified records of plants from this promontory, both from the mountains and from the sea coast. With a hope to settle some of these, I walked the whole sea margin from Tralee to Castlemaine, as well as spending some days on and in the neighbourhood of Brandon. My chief head-quarters were at Castlegregory, Cloghane, Ballynagall, and Dingle. With the exception of Dingle, a visitor should make previous arrangements at these places, and I would recommend him to enter the promontory with a supply of provisions. At Ballynagall, a retired coastguard, who gave me clean accommodation, told me no visitor had been there except fish-dealers since Du Noyer the geologist's time, and I found this lonely spot, by the western flank of Brandon, the most delightful in the peninsula.

I will mention some of the most interesting species which have been known as occurring in this part of Kerry; these are—

Lathyrus maritimus,
Bartsia viscosa,
Sibthorpia europea,
Pinguicula grandiflora,
Euphorbia hyberna,
Potamogeton nitens,
Rhynchospora fusca,
Carex punctata,
Trichomanes radicans,

and several alpine species, of which the rarest is *Alchemilla alpina*,

found elsewhere in Ireland I think only on Tonelagee, in county Wicklow. Of the above, Lathyrus and Sibthorpia have no other Irish locality.

In addition to these, have been recorded—

Saxifraga cœspitosa,	Poa alpina.
Scrophularia scorodonia.	

Of these, the claims of the Saxifrage rest on a single imperfect specimen from Brandon: I was unable to rediscover it. *Scrophularia scorodonia*, a record of Smith's, was no doubt an error, and the *Poa alpina*, which I also failed to find, and which is not at all likely to occur so far south, was probably *Poa annua*.

The following species, which I met with, are additions to the Flora of District 1, as given in the *Cybele* and its Supplement:—

Ranunculus lingua, Linn.	*Eleocharis uniglumis*, Link.
Trifolium fragiferum, Linn.	*E. pauciflora*, Link.
Hieracium vulgatum, Fries.	*Blysmus rufus*, Pang.
Polygonum viviparum, Linn.	*Kœleria cristata*, Pers.
Orchis pyramidalis, Linn.	*Ophioglossum lusitanicum*, Linn.
Listera cordata, R. Br.	

The undermentioned plants do not appear to have been recorded from the county Kerry. They are at any rate rare in the south-west of Ireland. My localities will be found in the body of this report:—

Arabis ciliata, R. Br.	Polygonum raii, Bab.
Cerastium semidecandrum, Linn.	Rumex hydrolapathum, Huds.
‡Silene anglica, Linn.	Euphorbia portlandica, Linn.
‡Althæa officinalis, Linn.	Juncus obtusiflorus, Ehrh.
Radiola millegrana, Sm.	Carex teretiuscula, Good.
Trifolium medium, Linn.	C. pallescens, Lam.
Œnanthe lachenalii, Gmel.	C. lævigata, Sm.
*Carduus marianus, Linn.	
Scrophularia aquatica, Linn.	
*Hyoscyamus niger, Linn.	
†Mentha pulegium, Linn.	

In the following account I shall only mention the local or rare species in this part of Ireland:—

On Wednesday, the 4th July, I left Tralee, keeping along the north coast for Castlegregory. About Tralee I noticed *Apium graveolens*, *Statice bahusiensis*, *Sagina maritima*, *Poa rigida*, and *P. loliacea*.

‡ The double dagger signifies *probably*; single dagger, *possibly*; and asterisk, *certainly*, introduced.

About Blennerville, a small suburb, with salt marshes adjoining, were the usual estuary species. *Carex vulpina* and *Bartsia viscosa* were observed here. *Juncus glaucus* also occurred sparingly; and along the roadside, *Senebiera didyma*, *Papaver dubium*, and *Stellaria graminea*.

After leaving the road, and crossing muddy dykes and salt marshes amongst Salicornia and Suæda, *Spergularia marina* and *Œnanthe pimpinelloides*, more of the before-mentioned Statice appeared in company with *Scirpus maritimus*. On a ditch bank here I gathered a remarkable variety of *Rosa canina*, erect, closely and desperately prickly, and with very numerous umbellately-arranged flowers, whose petals were deeply bilobed and very red. The leaflets were also unusually large. In a few miles the coast assumed the character of a low turf-bog, stretching along the narrower part of the estuary opposite Fenit. This is the northern margin of the Cahirconree range, and the mountain bog plants become oddly mixed with the salt swamp forms. Thus, alongside of *Aster tripolium*, *Armeria maritima*, and *Juncus maritimus*, occur *Myrica gale*, *Anagallis tenella*, *Eleocharis multicaulis*, and the common heathers. Here, too, occurred *Scirpus tabernæmontani*, a showy plant, and the large tussocky *Carex paniculata*, and in company with these a rare species, *Juncus obtusiflorus*. Still keeping through the muddy, slimy, border-land of bog and slob, I met with *Eleocharis uniglumis* (a most unsatisfactory species), *Lychnis flos-cuculi*, *Hypericum elodes*, *Carex limosa*, *Rhynchospora alba*, *Schenus nigricans*, Droseras, and other moor-land plants; and in the deeper holes occurred *Ranunculus baudotii*, *Zannichellia palustris*, and *Ruppia rostellata*. About three miles from Camp, *Juncus obtusiflorus* occurred again, and with it *Carex extensa*, sparingly, and *Triticum acuta*. Camp is a small village, seven or eight miles west from Tralee, and about a mile from the coast. In these marshes I also gathered *Carex dioica*, a northern species, which I did not expect to meet with in the extreme south-west of Ireland and at sea level. The northern and north-western portion of this peninsula, lying along and under the bleak influences of high mountain ranges, affords climate for several surprises of this nature; and probably in no part of the British islands could a more mixed assortment of plants be found, viewed with regard to their geographical distribution. *Osmunda regalis* grows along the ditches here luxuriantly in some places; *Habenaria chlorantha*, *Bartsia viscosa*, *Salix repens*, var. *argentea*, and *Viola curtisii* were noted; and in the neighbourhood of a rabbit-warren, *Cerastium tetranda*, *C. semidecandrum*, *Arenaria serpyllifolia*, *Scilla nutans*, and *Viola canina* occurred. Outside this drier coast of sandy pasture is a shingly beach, and amongst the stones grows the maritime variety of *Solanum dulcamara* (*S. marinum*), a woody, stunted plant, flowering profusely, and with the leaves somewhat glaucous, fleshy, and less divided than in the typical species. It occupied the position which *Mertensia maritima* would do if occurring. The usual plants, bent-grass, sea-chamomile, and bladder-campion now took the place of the wetter species, and *Asperula cynanchica*, a very characteristic

feature in the subsequent flora of the northern side of the peninsula, was first gathered. It is very local in Ireland, and has been recorded by Dr. David Moore from Castlegregory, near the present locality. *Thrincia hirta* was gathered here also, and previously in one or two places since Blennerville. The scenery here becomes diversified with pretty little glens descending from the uplands, in which occur holly, *Agrimonia eupatorium*, and the rose already mentioned, sometimes growing erect to 9 or 10 feet in height, with a stem an inch and a-half in diameter. *Œnanthe crocata*, rather rare in the west, was also gathered. Along the roadside, on the way up to Camp, I noted *Convolvulus arvensis*, and on the coast below, *Polygonum raii*, *Solanum dulcamara*, var. *marinum*, which occurred at intervals to Castlegregory; *Cakile maritima*, *Euphorbia paralias* and *Lycopus europæus* were also met with.

Thursday, July 5th.—Castlegregory lies in the south-eastern sinus of a sandy arm, thrust northwards into the sea for about four miles. It boasts of being the largest thatched village in Ireland. I devoted a day to making a circuit of this minor promontory, which corresponds well with that of Inch on the southern side. Near the village occur *Verbena officinalis* and *Ononis arvensis*, and on the sandhills I found the following species: *Asperula cynanchica*, very abundant, and whitening the ground in many places for a considerable area; *Kœleria cristata*, *Phleum arenarium*, *Arabis hirsuta*, *Orchis pyramidalis*, *Sagina nodosa* and the Euphorbia and Cerastia already mentioned. In low stony flats, between the sandhills north of Lough Gill, where the Ordnance Map marks lakes, but where I saw none, I gathered *Eleocharis pauciflora* plentifully, not found previously in the southern half of Ireland. Nearer the point, the characteristic sandhill plants, in addition to the Asperula, were *Trifolium procumbens*, *Convolvulus soldanella*, *Viola curtisii*, *Salsola kali*, and by a little fishing-place, *Senebiera coronopus*. At the extreme point this sandy spit is bound with rocks on which occur *Crithmum maritima* and *Beta maritima* abundantly. Outside this low stony limestone point lie the "Magherys," a group of islands well known to Irish archæologists. I had thought of visiting them, but their land-locked position looked too unpromising. Smith, in his *History of Kerry* already quoted from, speaks of *Scrophularia scorodonia*, as found near the Magherys on the coast of Tralee Bay. This record is, no doubt, erroneous. Can he have meant the Solanum, which occurs here again? *Asplenium marinum* also grows along these cliffs, while amongst the most interesting ruins at Kilshannig are *Hyoscyamus niger* and *Carduus marianus*. Having given time enough to this rather dull stretch of sandhills, I made for the stream out of Lough Gill, and thence, keeping the river and lake on my left, made a complete circuit. In this lake Dr. Moore found *Potamogeton nitens*. Close by the stream, near its embouchure at Lough Gill, I gathered *Blysmus rufus* in considerable quantity. This is another case of a northern species reaching unusually far south on the west coast of Ireland. Its most southern recorded loca-

lity in the British Isles is in Carnarvon, nearly a degree north of the present habitat. In Ireland, I am not positively aware of its occurring elsewhere south of Dublin Bay. In this stream, and along the northern shore of the lake, occurred *Potamogeton crispus*, *P. perfoliatus*, *P. heterophyllus*, *P. pectinatus*, and *Myriophyllum spicatum*. *Ranunculus baudotii* was also abundant, and about the middle of the lake occurred *Rumex hydrolapathum*, and in heavy marshes at its south-west end were *Carex paniculata*, *Nymphæa alba*, *Sium augustifolium*, *Helosciadium repens*, *Veronica scutellata*, *Carex teretiuscula*, *C. limosa*, and *C. pulicaris*.

On the following day, July 5th, I traversed the mountains, Benooskey, Slievenagower, Slievenalecka. Slieveanea, and Connor Hill to Dingle. Benooskey is 2715 feet, and reaches to alpine vegetation. The two commonest *bonâ fide* alpine species in Ireland occur from 300 feet below the summit upwards. These are *Salix herbacea* and *Carex rigida*. Armeria also occurs, and it is always surprising to meet this species at the summit and at the base of sea-coast mountains while it does not occupy the middle distance. Slievemore in Achill gives a remarkable instance of this. *Saxifraga stellaris* and *Sedum rhodiola* accompanied the true alpines, and in this latitude they nearly deserve the same appellation. Other interesting species met with to-day were *Pinguicula grandiflora*, *Lobelia dortmanna*, *Isöetes lacustris*, *Carex fulva*, *Saxifraga umbrosa*, and *S. geum*. The altitudinal particulars will be given subsequently. The district gone over to-day was varied and interesting, and many of the glens and lake shores would repay more elaborate search. I crossed habitats of Killarney fern and Sibthorpia, but my labours were chiefly devoted to the higher ground. Towards night I sighted Dingle, and was fain to look for the hotel. Thinking I could telegraph to Castlegregory, I descended to the town, which looked so tempting in its lake-like bay. I had to remain the night, however, without sending word to my hospitable landlady, to the no small alarm of the Castlegregorians.

July 6th.—Walked to Connor Hill, and thence along the Brandon ridge by Beenduff, Ballysitteragh, Gearhane, and Brandon Peak to the summit. About a mile beyond the summit I descended by two small tarns into the head of the Owenafeana valley, and crossing its southern side made my way down to Cloghane, where I arranged about accommodation, and walked into Castlegregory. Remembering the frequent detours and climbing bouts, this was a severe day's work. At Beenabrock, and afterwards, I gathered *Salix herbacea*, *Saxifraga stellaris*, and *Sedum rhodiola*. Armeria also occurred in many places as at Brandon Peak, which is south of the summit, and nearly 400 feet lower than Brandon. The alpine plants on this chain occur on the eastern side of its upper ridges. After Brandon Peak, I soon met with *Cystopteris fragilis* and *Polystichum lonchitis*, the latter very sparingly. A fine range of cliffs commences here; and keeping a couple of hundred feet below the crest I found *Oxyria reniformis*, *Alchemilla alpina*, and *Asplenium viride*. *Aira cæspitosa* was the nearest thing to

Poa alpina I could discover, excepting, perhaps, *Poa annua*. *Saxifraga umbrosa* and *S. hirta* (vars. *affinis* and *decipiens*) occurred. At the head of the valley above the two small lakes north of Coomaknock Lake is good alpine ground. *Alchemilla alpina* is frequent. Lower down I gathered *Listera cordata*. I afterwards found this northern orchid in several different places. This is the third case of a Scottish species finding a home far south. Its most southern known Irish range was in Wicklow. I have, however, also discovered it in the Waterford mountains. In the same valley I gathered *Hieracium anglicum*. On reaching Castlegregory I was received with a reproachful welcome. The inhabitants, unused to such vagaries, had concluded that as I had not returned to my dinner I must needs be lost on the mountains, and had searched for me far into the night with an honest and entirely unmerited assiduity for my welfare. I was just in time to disorganize a renewed expedition.

On the 7th July I examined the coast from Castlegregory to Cloghane. Before doing so I called on Dr. Busted, who told me of one or two localities for *Trichomanes radicans* (Killarney fern). He also believes that Du Noyer told him of the maiden-hair growing on Cahirconree by one of the streams above Archdeacon Rowan's cottage. This would probably be Andrews' station, as given in the *Cybele Hibernica*, and the most southern in Ireland; I failed to find it there in 1881. Speaking of the Killarney fern, he remarked that it grew in plenty in several places where it is now exterminated, from twenty to ten years ago. The few remaining habitats with which I became acquainted are carefully preserved by Lord Ventry, on whose property they are, and through whose kindness, and that of the Rev. Mr. Anderson of Dingle, I got directed to them. The range of *Sibthorpia europæa* is also well known to these gentlemen; and these species and the neighbourhood of their known habitats I rather avoided, endeavouring to reach the unvisited parts of the promontory.

Continuing my coast exploration, or rather that of the marshy murrough west of Lough Gill, parallel to the sea, I kept along the edges of a most treacherous dyke in a floating bog for a few miles. It is the drain or stream which runs into the lake at the S. W. corner. Near the lake I gathered *Scirpus savii*, *Carex teretriuscula*, and *Gymnadenia conopsea* in new localities. All along the coast here on the dry sandy pastures, *Asperula cynanchica* is the special feature in the vegetation. The rayless *Senecio jacobæa* (*flosculosus*) occurs as usual in such places. Along this most impracticable stream, where wading, swimming, and walking were alike unsafe, I gathered *Utricularia vulgaris*, *Rumex hydrolapathum*, *Potamogeton pusillus*, *Potamogeton natans* (in its bog-hole membranous-lanceolate-leaved flowerless variety), *Carex vulpina*, *Ranunculus lingua*, *Veronica scutellata*, and *Sparganium simplex*. Nearer Femoyle, *Carex remota*, *C. extensa*, and the two Œnanthes occur; and in thickets on a headland, before striking up Cloghane estuary, I found *Carex fulva*, *C. lævigata*, and *C. pallescens*. Of these plants, *Ranuncula lingua* is the rarest, not having been recorded from

the south-western counties, and is a scarce plant everywhere in Ireland. Here it occurred sparingly.

On the following day (Monday, 8th July), I accomplished an arduous journey round the coast from Cloghane under Brandon Point and Brandon Head to Ballydavid and thence into Dingle. Near Quay village I met with *Arabis hirsuta*, *Asperula cynanchica*, and *Bartsia viscosa*, where the coast was low and sandy; and in other places, *Eupatorium cannabinum*, *Agrimonia eupatorium*, *Rosa pimpinellifolia*, *Salix repens*, *Asplenium marinum*, and the pink variety of *Convolvulus sepium*. *Carex extensa* also occurs here on wet rocky ledges by the sea. Where the coast becomes steeper the vegetation is composed chiefly of oak, osmunda, London pride, foxglove, *Sedum rhodiola*, *Hypericum androsæmum*, *Silene maritima*, *Beta maritima*, *Sedum anglicum*, *Scilla nutans*, *Lastræa æmula*, *Empetrum nigrum*, and *Eleocharis multicaulis*. This list of species gives a fair idea of the flora of a south-western headland, a mixture of Atlantic and mountain plants descending to within one hundred feet of sea level, where precipitous storm-beaten cliffs barred their further progress. It is important to notice that two northern species, *Sedum rhodiola* and *Empetrum nigrum*, descend to sea level in Kerry. Having rounded Brandon Point, and while scrambling on my hands and knees on very steep banks at the verge of the cliffs, marked Deelick Point on the inch Ordnance Map, I gathered the diminutive *Ophioglossum lusitanicum*. There was here but a small quantity of it. Subsequently I gathered it plentifully on Sybil Head, a similar situation, about fifteen miles to the south-west, and later in the same year, near Slieve League in Donegal. I have thus found it on two Donegal headlands, Horn Head and Slieve League, and two in Kerry, Brandon Point and Sybil Head. The majority of botanists who have examined my specimens decide that it is true *O. lusitanicum*, and a somewhat hasty comparison with types in the Kew Herbarium appeared to me to warrant this decision. Syme, however, considers that the fructification season of my plant, which takes place in latter summer and autumn, is against its being identical with the Channel Island species, which is fertile in winter, and refers it to *O. polyphyllum*. Climatic differences might, however, be sufficient to effect this discrepancy. On these steep slopes I found *Radiola millegrana*. Both these plants were so minute, owing to their exposed condition, that had I been progressing in an erect position I should have probably passed them by, and the dwarf adder's tongue has to be carefully looked for. A little farther, and I again gathered *Listera cordata*, a species which is much commoner than is supposed. I know of no plant which eludes observation so successfully. If search be made on the north side of a mountain at a moderate elevation where the heather is old and lies recumbent on a steep, mossy, and somewhat rocky slope, this little orchid will be frequently found. But the heather has usually to be lifted before it is visible, and its known habitats are generally those in the neighbourhood of such localities, where it is abundant, and may have spread to opener spaces. Just here I opened a bay of

extreme grandeur, bound on three sides by lofty precipices, and with a depth and sea frontage of about half a mile. A couple of squatters had here (Arraghglin) the bleakest shepherds' homes I have yet seen; no road or even track leads to them, and there is no approach except over the Bandon ridge, whose nose I had now rounded. On these headlands by a brook I gathered *Equisetum sylvaticum*, and in the most exposed places here, as all along the west coast of Ireland, *Scilla nutans* thrives.

A long and laborious climb of several hours' duration, rendered worse by a growing mist of rain which obscured the vision in all directions, brought me round Brandon Head at altitudes varying from 500 to 1200 feet. At Beenaman (1238 feet, Ord. Survey), I gathered *Saxifraga hirsuta*, in company with *Sedum rhodiola*. A little farther west, on the face of some masses of rock looking seawards, at 1180 feet above sea-level, I found a couple of luxuriant plants of *Oxyria reniformis* on the neck of a rocky promontory. This is not an instance of an alpine species being carried down by a stream, and is an unusually low level for this plant to occur at. It is probably, however, accidental, and due to a gale of wind or some such cause. On the low coast west of Tiduff, *Sedum rhodiola* occurs abundantly to sea level. Along here, *Kœleria cristata*, *Schœnus nigricans*, *Polygala depressa* were frequent near the sea, and in waste places a little inland on the lowlands west of Brandon. *Bartsia viscosa* is the commonest weed. Here, too, I gathered the upright form of *Mentha pulegium* in ditches by the roadside. Along the road, as I walked to Dingle, I noted *Anthemis nobilis* and *Senebiera didyma*.

On the 9th I crossed the Brandon Ridge, between Ballysitteragh, and examined the chain of lakes on the eastern side, Lough Duff, Lough Gal, and others. It was a day of blinding rain. On the way up the western slopes, I gathered *Euphorbia hyberna;* and above Lough Duff, *Hymenophillum tunbrigense*, *Carex lævigata*, *Geum rivale*, *Hieracium anglicum*, and others of less interest. In the lakes, *Isöetes lacustris* occurs; and along their margins, *Carex paniculata*, *C. ovalis*, *Sparganium minimum*, and *Scirpus fluitans*. Near Cloghane, by a roadside rivulet, *Althæa officinalis* grows sparingly. I noted it elsewhere in the neighbourhood as a cottage-garden plant; and it had, no doubt, escaped here by some accident.

On the 10th July I finally left Cloghane. The mountains were enveloped in a heavy cloud, more and more aqueous as I ascended. In order to avoid loss of time, I accepted the offer of a mountaineer I met on the way to accompany me, and bring me the quickest way to the largest loughs under Brandon Peak to its east. The first lough, Lough Cruttia, lies at about 700 feet above sea level. Between it and Lough Nalacken, *Sagina subulata* grows in company with *Saxifraga stellaris* and *Sedum rhodiola*. Higher up, at the base of the cliffs, I met with *Juniperus nana* very sparingly, and *Plantago maritima*. The surface here is a desolate scene of bare rocks and boulders, lying on an equally bare floor of polished and ice-worn

grit. I had put many leading questions to my companion with a hope of extracting some reliable information on the natural history of the district, and I may be excused for repeating the following :— "In Lough Veagh, or the 'white lake' (one of those which I had visited yesterday, but which, as is frequently the case, has a different name on the map), the people get pearl mussels. Three or four men went there lately with oilskins and dived for them. These come off an enormous animal called the 'carrabuncle,' which is often seen glittering like silver in the water at night. This animal has gold and jewels and precious stones hanging to it, and shells galore ; the inside of the shells shines with gold. The divers hoped to have caught the 'carrabuncle' himself." This shining appearance in the water of the Kerry lakes is alluded to by Smith, who gives it the same name, though without a full explanation like the present. It is to be hoped the "carrabuncle" will find its way to our new National Museum.

Turning a deaf ear to my cicerone's remonstrances, and telling him to meet me by what way he chose on the summit, I made my way into the cliffs by a somewhat dangerous gully, at about 1650 feet above level. After a stiff climb for 300 feet, I came on the best alpine ground in Brandon, better than any on MacGillicuddy's Reeks. This extended for about 400 feet vertically, and contained *Saxifraga affinis*, *Oxyria reniformis*, *Saussurea alpina*, *Cystopteris fragilis*, *Polystichum lonchitis* (very sparingly), *Asplenium viride*, *Alchemilla alpina*, and other commoner mountain plants. At 2500 feet there occurred a small patch of Scotch heather, *Erica cinerea*, an unusual elevation. These alpines were abundant on wet ledges and banks of broken and precipitous ground. Having rounded the head of this glen above Coomaknock lakes, I came out on the ridge and followed it northwards by the head of the Feany valley. *Salix herbacea* and *Carex rigida* occurred plentifully, and as usual above the other alpines, or at least in more exposed situations. About a mile and an eighth north of the summit of Brandon along this ridge, and close to the ruins of an old signal tower, I discovered *Polygonum viviparum*, a high alpine species, not known in Ireland south of Ben Bulben, in Sligo. From here I struck down the west side of Brandon and walked into Dingle.

On the 11th I examined the coast from Dingle westwards round the harbour and along the outer shore to Ventry. The formation along here is often of slate, which forms polished walls and slides, and leaves little scope for plant-growth. Between Dingle and Milltown, by a road that would be a disgrace to the Desert of the Exodus, *Erodium moschatum* grows. I have not seen this plant in remoter sandhills or anywhere except in obviously suspicious localities in Ireland. *Vicia angustifolia* and *Lotus major* were noted along the ditch banks, and by Burnham Bridge is a plentiful establishment of *Scrophularia aquatica* at the mouth of a brook. Along the coast here Lord Ventry, adopting Smith's suggestion (*History of Kerry*, p. 180, note [p]), has introduced *Hippophæ rhamnoides* for fencing and binding together the sandy soil. It has not thriven to such an extent as at

Courtown, on the east side in County Wexford, but it has spread slightly. *Carex extensa* is abundant here. Although continually watching, I could see no *Atriplices* except *A. Babingtonii.* Near the point at the mouth of the harbour, opposite Dingle, *Trifolium medium* is abundant, and with it *Saxifraga umbrosa* as a seaside species on a low coast. Having rounded the point and turned westwards, samphire becomes frequent, *Kœleria cristata* and *Festuca scincoides*, and a monstrous form of *Cynosurus cristatus*, with ovate subpaniculate inflorescence. On the slate cliffs, under Ballymacadoyle Hill, a great breeding place for shags, I gathered *Euphorbia portlandica.* Near Ballymore, *Habenaria viridis*, not uncommon, and on my way back to Dingle from Ventry, *Salix smithiana* and *Scrophularia aquatica* occurred in several places. On the following day (12th), I went back to Ventry, round the west side of the harbour, and up Mount Eagle. Near Ventry, in a marsh on the sands, *Carex dioica, Utricularia minor*, and *U. vulgaris* were noted. On poor upland slopes, east of Mount Eagle, *Euphorbia hyberna, Bartsia viscosa*, and *Lotus major* prevail. *Alchemilla vulgaris* reaches large dimensions here, some of the leaves I measured being six inches across. At Mount Eagle Lough, *Isöetes lacustris* and *Sedum rhodiola* represent the northern species. In marshy, rushy ground west of Ventry Harbour, *Œnanthe pimpinelloides* and *Triticum acutum* are common. From Ventry Harbour, I crossed the isthmus of bog and mountain to its counterpart, Smerwick Harbour, on the northern shore of the peninsula across about four miles, to Ballynagall.

July 13th.—Followed the coast line from Ballynagall northwards and eastwards, round Ballydavid Head, to the point I had reached on the 8th, close to Ballyvoe. Nothing of particular interest was met with until reaching a sandy bay at Feohanagh, about two miles away. *Althæa officinalis* occurred by a brook between a cabin and the sea. At the sandy bay in the southern nook formed by Ballydavid Head, close to Feohanagh, *Trifolium fragiferum* is abundant, forming the sward on both sides at the mouth of a stream; *Kœleria cristata* and *Asperula cynanchica* also occur here, and by the roadside along the side of the bay north of Feohanagh, *Atriplex angustifolia* and *Radiola millegrana* are not uncommon. Amongst heavy heather, at about 700 feet above sea level near Ballydavid Signal Tower, *Listera cordata* was again found. Along the Feohanagh river, about a mile up, *Carex limosa, Achillea ptarmica, Veronica scutellata*, and *Œnanthe crocata* were the most noteworthy, and on the way back across the moorland I observed *Scirpus savii, Centunculus minimus, Rhynchospora alba, Utricularia minor, Scutellaria minor*, and *Radiola millegrana.* Pretty white varieties of *Jasione montana* and *Prunella vulgaris* decorate the banks, and I have never seen *Hypericum elodes* so abundant anywhere. In the bed of the stream at Murriagh, a squalid group of hovels near Ballynagall, *Mentha pulegium* is very abundant. In all these boggy places, *Alisma ranunculoides* is a characteristic species. A low, wet stretch of ground, in some places inundated, between Castle Gallarus and the

sea, yielded *Sium augustifolium*, *Bidens cernua*, *Eleocharis multicaulis*, and abundance of *Blysmus rufus*.

The following day (July 14th) was one of those prevalent experiences which render one of the opinion that the western seaboard of Ireland is unfit for human habitation—a day of enduring and extraordinarily soaking rain. I continued the coast line west from Gallarus bog to the western horn of Smerwick Harbour, round the Three Sisters, and Sybil Head to Clogher Head. Near Gallarus, *Euonymus europæus*, *Carex teretiuscula*, *C. limosa*, *C. dioica*, *C. extensa*, and *Potamogeton pectinatus* were noted. On the sands, at west side of harbour, *Convolvulus soldanella*, *Orchis pyramidalis*, *Rosa pimpinellifolia*, *Asperula cynanchica*, *Polygonum raii*, *and Equisetum palustre* were met with. On the eastern side of the "Three Sisters," in steep overhanging cliffs, I was interested to observe a heronry. There appeared to be seven or eight pairs of birds, and some of the young still remained with the nests. I learned from a fisherman that herons had formerly bred on the cliffs between Dallydavid and Brandon Head, but having had their nests robbed they had discovered this site, which has baffled all the boys of the country. St. John, in his *Wild Sports of the Highlands*, notices a similar case on wooded cliffs in Cromarty. Where there is no timber, these birds have been sometimes known to build on the ground, but I know of no other instance of their selecting bare sea cliffs. The "Three Sisters" is also a breeding station for greater black-backed gulls and peregrine falcons, and I have never seen choughs so abundant as here, not even on the coast of the Rosses, county Donegal. A large flock of these birds kept continually wheeling and screaming around me, and I counted upwards of a hundred individuals together on one occasion. On the seaward side of a low wall along the exposed crest of the "Three Sisters," between the second and third of the eminences so named, I found abundance of the dwarf adder's tongue (*O. lusitanicum*) already mentioned. No further species of interest occurred except a curious form of *Centaurea nigra*, very stunted, with a solitary flower, very vividly coloured and large, and bearing conspicuous ray florets, at Doon Point. In Ferriter's Cove, *Asperula cynanchica* maintains its ground sparingly, but the flora of this exposed and storm-swept extremity is very scanty. In this sandy bay, *Convolvulus soldanella*, *Salsola kali*, Cakile, and Beta occur; and here I struck across country back to Ballynagall, as marked on the map, Ballydavid as called on the spot. On the way near Ballyferriter, I gathered *Stachys arvensis* in several places, and *Pimpinella magna* along ditch banks by the road, both local species, but already recorded from Kerry.

July 15th.—Having rowed a curragh across to the south-west corner of Smerwick Harbour, I explored the hills behind Ballyferriter, and, striking across Croaghmartin, took up the coast line at Clogher Head, which I followed right round Dunmore Head, lying abreast of the Blasquets at the extreme west of Ireland. From here the coast wends east round Slea Head, where the magnificent scenery is dis-

figured by an unfinished, ill-engineered, and unnecessary road cutting, which is balanced on the vertically-placed edges of the slate formation, so that it is ever-toppling over and sliding outwards into the sea. No doubt Nature will eventually assert and restore her beauty. Along this coast there are no plants of interest. The springy sward is composed chiefly of stunted phanerogams closely adpressed to the ground. The air is bracing in the extreme, there being, as I felt, a marked difference in favour of Smerwick Harbour and the northern side as compared with Dingle. The cliff scenery is bold and rugged, but neither precipitous nor grand, and is the haunt of those fowls which breed mostly on shelving rocks, such as the oystercatcher, whose noisy and varied, loud and breathless song, resounded above the surge. The flattened sod in the most exposed places consisted of *Euphrasia officinalis*, *Eleocharis multicaulis*, and *E. palustris*, *Salix repens*, *Molinia cærulea*, *Thymus serpyllum*, *Potentilla tormentilla*, *Armeria*, *Hydrocotyle*, *Anagallis tenella*, *Rumex acetosella*, and *Sedum anglicum*. At Dunmore Head I meditated a swim to the Blasquets, about an English mile, but the current appeared impracticable. Near here I noticed *Senebiera coronopus*, which is rare in the west.

On the 16th I left Ballynagall, and crossing east by Kilmalkedar I examined Ballinloghig Lough or Crawley's Lake, as it is called in the country. On old walls about Kilmalkedar I gathered some interesting Scolopendrium sports, and close by the beautiful little ruined church *Scrophularia aquatica* was again met with. At the lake, with commoner plants, occurred *Cladium mariscus*, *Scutellaria minor*, *Sparganium simplex*, and *Utricularia minor*. At Ballinloghig *Anthemis nobilis* is very common. From here I went up the glen east to Gearhane, in order to get the westward elevations of plants in the middle portion of the range, and crossed down to the lakes and swamps at the base of Connor Hill, chiefly to look for *Rhynchospora fusca*, which I failed altogether to find. Along the southern margin of Lough Gal, I met with *Sparganium minimum*, *Carex pallescens*, and *Hieracum vulgatum* in one place very sparingly. *Hymenophyllum tunbrigense* was seen several times in the day. In the evening I made my way into Dingle, where I had a visit from the Rev. Mr. Anderson, who kindly gave me some information about the ferns and rarities of the district.

On the 17th, a long and weary day's work brought me round the coast by a lofty and steeply-sloping series of headlands to Anniscaul. Near Dingle, at the mouth of the harbour, cormorants and black guillemots have nesting places. Here I searched unsuccessfully for *Carex punctata*, formerly gathered by Mr. Oliver; *Erodium moschatum* occurs close by. On rounding the outer point into Trabeg, I came to low, sandy banks, which looked promising. I gathered here *Arabis hirsuta*, and with it *Arabis ciliata*. Of the latter I have no doubt, but owing to the abominable inconveniences I met with at Anniscaul, my specimens of the day were all lost. A little further up, *Euphorbia portlandica* was again met with, and in the wide tract of rushy and

tide-riven slobland at the head of the estuary *Œnanthe lachinalii*, *Blysmus rufus*, and *Carex extensa* are common. *Asperula cynanchica* has disappeared on this shore of the promontory. On the east side of the estuary, in corn-fields by the coast, occurred *Scandix pecten-veneris*, *Stachys arvensis*, and *Silene anglica*, the latter abundantly. The distribution of *Schœnus nigricans* is curious, salt marshes and mountain uplands being its favourite haunts. *Senecio sylvaticus* was first met with at Bull's Head, where I looked on one of the loveliest views of mountain and sea I ever beheld. MacGillicuddy's Reeks were clear from end to end, although Brandon, as is frequently the case, was clouded. At Minard there is an interesting old castle and a narrow estuarine flat between steep hills of most unusual appearance—a sort of winding fiord a few feet above sea level, about a mile and a-half long and a-quarter of a mile wide, with a boundary of sheer and steep hills, and filled with impassable bog, bog-plants, and aquatic fowls. The plants were not rare, and I went out as far as possible from one tussock to another of *Carex paniculata* without meeting any novelty. The contrast between the dry slopes and the level bog is here so remarkable as to give one the idea of an attempt at artificial reclamation.

On the 18th I was again doomed to disappointment. I made a desperate effort to verify the only Irish habitat of *Lathyrus maritimus* at Inch Point. It was desperate, because a wearier trudge than that round Inch Point I have seldom undertaken—amongst endless sand-hills and in a blazing sun. But there was neither vetch nor pea at Inch Point. The original record comes from Smith's *Kerry*, perhaps the most unreliable authority on Irish botany that is ever quoted from, or it might be fairer to say "unintelligible," for no doubt in his records he often alluded to plants known to himself whose identity we cannot determine. In this instance, besides the record of *Pisum maritimum*, "on the south point of Inch Island in the bay of Castlemaine in considerable quantities," there is also at p. 174 (ed. 1756), another and bewildering statement, "towards the southern point of the island (as it is called, although properly an isthmus), considerable quantities of white peas grow spontaneously, the seed of which was probably scattered here by some shipwreck." Now the flowers of *Lathyrus maritimus* are purple. I cannot learn that the plant has ever been gathered here since Smith's time, but Mr. More is of opinion that the habitat is correct. The plant appeared in a collection bought by my friend Mr. Barrington from a coastguard of the place. He informs me it is labelled "Sandhills, Killorglin Bay, 1845." This points to a different locality, since Killorglin is on the opposite or south side of Dingle Bay, about ten miles from Inch in a south-easterly direction. I went right round the isthmus and scoured the point carefully, but without success. I noted *Thrincia hirta*, *Euphorbia paralias*, *E. portlandica*, *Gentiana campestris*, and in ditches near the mainland *Lycopus europæus*. From here I made my way into Tralee, as the coast became low and cultivated, and devoid of botanical interest.

My observations, in addition to those of previous observers, would place the flora of this district at 510 species, which is just equal to that of Innishowen, a peninsula of about the same size in Donegal.[1] I am not now proposing to enumerate all the species observed in a limited visit like the present; but with a view to bringing out the salient points, I will briefly analyse the flora into its groups as given by Watson:—

The alpine plants of Brandon (for the rest of the peninsula adds none) are—

Alchemilla alpina,
Sedum rhodiola,
Saxifraga stellaris,
S. hirta et vars,
Saussurea alpina,
Hieracium anglicum,
Polygonum viviparum,
Oxyria reniformis,
Salix herbacea,
Juniperus nana,
Carex rigida,
Polystichum lonchitis,
Asplenium viride,
Isöetes lacustris;

four more than I gathered on the Reeks in 1881. A few of these cannot be correctly termed alpine in Ireland.

The northern plants found in the peninsula are—

Sagina subulata,
Antennaria dioica,
Hieracium vulgatum,
Lobelia dortmanna,
Pinguicula vulgaris,
Empetrum nigrum,
Listera cordata,
Potamogeton nitens,
Blysmus rufus,
Eleocharis uniglumis,
Carex dioica,
C. limosa;

while of Watson's Atlantic type occur—

Viola curtisii,
Erodium moschatum,
Sedum anglicum,
Cotyledon umbilicus,
Crithmum maritimum,
Bartsia viscosa,
Sibthorpia europæa,
Pinguicula lusitanica,
Euphorbia hyberna,
E. paralias,
E. portlandica,
Rhynchospora fusca,
Lastræa œmula,
Adiantum capillus-veneris,
Hymenophyllum tunbrigense,
H. wilsoni.

To which may be added a few extreme members of the Atlantic group—

Saxifraga geum et hirsuta,
S. umbrosa,
Pinguicula grandiflora,
Trichomanes radicans,
Carex punctata.

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[1] *Vide* "On the Flora of Innishowen, Co. Donegal," by H. C. Hart, *Journal of Botany*, 1883.

Of this latter group, a few more, such as *Carum verticillatum*, and *Scirpus savii*, probably occur also.

I will now give a table of the altitudes at which the mountain species reach their upper and lower limits. I have already given an account of the altitudinal range of plants in the McGillicuddy's Reeks, which has been published (*Proceedings*, vol. iii. p. 573). Brandon, although lower and much less extensive, and apparently less adapted as a home for alpine plants, has a larger variety than the Reeks, and its proximity to the sea modifies the range of a few. This is probably due to its undoubtedly wetter climate, the outer prominence catching and condensing much moisture which would otherwise reach the Reeks, and the moister saline atmosphere at its base, which to a slight degree assimilates the conditions for plant-life of ocean and alpine cliffs. Moreover, the whole peninsula is much more exposed to winds, currents, drift, and other northern influences than the rest of Kerry, to which it acts as a sort of screen or shelter, a position which has rendered it originally more likely to be peopled by invaders from the north, and now better fitted to enable their descendants to maintain their lingering and precarious tenure. It should be noted also that the alpine plants of Brandon only exist where entirely free from west and south-west winds.

In the following table, *the commoner lowland plants which ascend the mountains are not included, except when they occur at a greater elevation than they do on MacGillicuddy's Reeks* (vide *Proceedings*, vol. iii. p. 577, 1882). A few notes of heights are extracted from a short Paper of mine on "Mountain Plants in Kerry," *Journal of Botany*, June, 1882, where I have given an account of the flora of the Caherconree or Slieve Mish range.

Brandon summit, 3127 feet.

Cerastium triviale, Link.
Campanula rotundifolia, Linn.
Jasione montana, Linn.
Luzula campestris, D.C.
Poa annua, Linn.

Brandon Cliffs (looking north-east), 3000 feet.

Alchemilla vulgaris, Linn.

Saxifraga umbrosa, Linn. To sea level in many parts of the peninsula.

S. decipiens, Sm. To 2450 feet between Brandon and Brandon Peak.

Sedum rhodiola, D.C. To sea level between Brandon Head and Ballydavid Head; occurs also on Mount Eagle, Benooskey, Cahirconree, &c., and at intermediate heights on western slopes.

Oxyria reniformis, Hook. To 2000 feet above Lake Nalacken, and at 1150 feet on Brandon Head.

Carex rigida, Good. At 2500 feet at Caherconree, 2200 on Slieveanea, 2400 on Benooskey; lower limit at 2020 on Slieveanea.

Cystopteris fragilis, Bernh. Also at 2650 feet on Caherconrey; lower limit at 2000 feet above Lake Nalacken.

2850 feet.

Saxifraga stellaris, Linn. Also at 2650 feet on Benooskey and Caherconree; common, and occurs at 850 feet at Cruttia Lake, and at 1150 on western side of Brandon above Ballinloghig, quite non-alpine situations.
Armeria maritima, Willd. To 2000 feet above Lake Nalacken; also at 2500 feet on Benooskee and Caherconree; soon vanishing till near sea level.
Lastræa abbreviata, *D.C.* and *L. dilatata*, Presl.

Brandon, Head of Feany Valley (cliffs looking north-east),

2800 feet.

Alchemilla alpina, Linn. Also at 2250 feet below Brandon Peak lower limit at 2200 feet above Lake Nalacken.

Brandon, above Lake Nalacken (cliffs looking east),

2700 feet.

Chrysosplenium oppositifolium, Linn.

Brandon ridge (between Brandon Peak and the summit),

2650 feet.

Geum rivale, Linn. Not unfrequent lower down.
Taraxacum dens-leonis, Desf. And at 2200 feet above Lake Nalacken.
Melampyrum pratense, Linn.
Valeriana officinalis, Linn.

Caherconree (cliffs looking east), at 2650 feet.

Cochlearia officinalis, Linn.
Sedum anglicum, Huds. And at 1900 feet at Slieveanea and Connor Hill.
Saxifraga geum, Linn. At 1900 on Slieveanea, and common lower; var. *hirsuta* occurs at 1650 on Brandon above Lake Nalacken.
Scabiosa succisa, Linn. And at 2300 feet on Brandon.
Primula vulgaris, Huds. And at 2350 feet on Brandon.
Salix herbacea, Linn. 2500 on Benooskey, and on Pierasmore, north of Brandon; lower limit at 1900 feet on Slieveanea and Connor Hill.
Carex flava, Linn. And at 2200 feet on Brandon.
Poa pratensis, Linn.
Saxifraga affinis, Don. And at about this height on Brandon to 1950 above Lake Nalacken.
Athyrium filix-fœmina, Roth.

2550 feet.

Oxalis acetosella, Linn.

Benooskey, 2500 feet.

Antennaria dioica, Gœrt. Sparingly, and not seen elsewhere.

Brandon (cliffs looking east above Lake Nalacken),

2500 feet.

Polygala depressa, Wend.
Erica cinerea, Linn. Not abundant for about 500 feet lower; occurs at 2300 on Benooskey.
Carex pilulifera, Linn. Usually ceases at about 1500 feet when *C. pulicaris* begins to be frequent.
Asplenium trichomanes, Linn.

Brandon (between Brandon Peak and the summit),

2450 feet.

Pinguicula vulgaris, Linn. Also at 2100 feet.
Polystichum lonchitis, Roth. Also sparingly in Feany Valley at about 2000 feet.
Hymenophyllum unilaterale, Willd. Frequent lower down.
Asplenium viride, Huds. Lower limit at 2100 feet above Lake Nalacken.

Brandon, above Lough Nalacken (cliffs looking east),

2380 feet.

Saussurea alpina, D.C. Abundant here to 2000 feet; not seen elsewhere on Brandon.
Orchis maculata, Linn.

Pierasmore ridge, north of Brandon, 2380 feet.

Bellis perennis, Linn.
Achillea millefolium, Linn.
Plantago lanceolata, Linn.
Polygonum viviparum, Linn., the only locality for the alpine bistort. *Carex rigida* and the tufted Saxifrage also occur to keep it company. Its lowland neighbours probably reached this unusual altitude by the old track close by to a ruined signal-tower. *Plantago lanceolata* also obtains at 2200 feet, above Lake Nalacken, and 1950 on Breenabrock.

Brandon Peak, 2000 feet.

Juncus supinus, Mœnch.

Beenabrock, 1950 feet.

Veronica officinalis, Linn.

Benooskey, 1900 feet.

Pyrus aucuparia, Gaert.

Brandon (above Lake Nalacken), 1850 feet.

Carex vulgaris, Fries. A variety with sooty black glumes occurs on Brandon, above Lake Nalacken, at 1870 feet.
Lastræa æmula, Brack.

Benooskey, 1800 feet.

Pinguicula grandiflora, Lam. Frequent at lower elevations.
Empetrum nigrum, Linn. At about the same height on Connor Hill, and near sea level on Brandon Head.

Connor Hill, 1700 feet.

Sibthorpia europæa, Linn. And in several places between Castlegregory and Brandon (Rev. T. Anderson).

Benooskey, 1650 feet.

Trifolium repens, Linn.

Brandon (above Lake Nalacken), 1650 feet.

Sagina subulata, Wimm. To Lake Cruttia at 850 feet. Only locality in the county Kerry.
Juniperus nana, Linn. Very rare here, and not seen elsewhere on the Kerry mountains.
Pteris aquilina, Linn. Not common on Brandon.

The same at 1500 feet.

Carex pulicaris, Linn. Common at lower levels at about 800 feet; then more local.
Lycopodium selago, Linn. Frequent for a few hundred feet lower down, and at about this altitude.

Benooskey, 1500 feet.

Ulex gallii, Planch.

The same at 1450 feet.

Erica tetralix, Linn.

Lough Adoon, near Slieveanea, 1450 feet.

Carex fulva, Good. (*C. Honschuchiana*, Hoppe). Also by Lough Duff and in Feany Valley.

Benooskey, 1400 feet.

Schœnus nigricans, Linn. Common lower down.

Feany Valley, Brandon, at 1300 feet.

Hieracium anglicum, Fries. Very scarce here, and not seen above; at 700 feet on Gearhane.
Hedera helix, Linn.
Prunella vulgaris, Linn.
Listera cordata, R. Br. Also on Ballydavid Head and Brandon Head at lower levels.

Lough Barrot (near Slievecanea), 1280 feet.

Lobelia dortmanna, Linn. In most of the larger mountain lakes at lower levels.
Myriophyllum alterniflorum, D.C. In all the lower mountain lakes.
Litorella lacustris, Linn. Common in the lower mountain lakes.
Polygonum natans, Linn. Abundant below.
Betula alba, Linn.
Isöetes lacustris, Linn. Also in Lough Duff, Mount Eagle Lake, &c.

Brandon, Lake Nalacken, 1250 feet.

Plantago maritima, Linn. Probably occurs higher, but I did not meet it.

Brandon, Ballinloghig, at 1100 feet.

Lathyrus macrorrhizus, Wimm.

Brandon, Feany Valley, 1000 feet.

Sanicula europœa, Linn. Common.
Myrica gale, Linn. Common below on the moorlands.
Eleocharis multicaulis, Sm. Abundant, and characteristic of wet rills, &c., lower.
Hymenophyllum tunbrigense, Sm. Frequent lower down.
(*Trichomanes radicans*, Sm. About the upper limit of the Killarney fern).

Brandon, Ballinloghig, at 1000 feet.

Geranium robertianum, Linn.

Benooskey, 700 feet.

Hypericum elodes, Linn.
Rhynchospora alba, Vall.

Gearhane (Brandon), 700 feet.

Asplenium adiantum-nigrum, Linn.
Carex lœvigata, Sm.

Mount Eagle, 700 feet.

Rubus fruticosus, var. *villicaulis*, west and north.
Lotus major, Scop.
Euphorbia hyberna, Linn.

Up to this height, on Brandon and elsewhere, occurred also—

Hypericum androsæmum,	Scirpus fluitans,
Helosciadium inundatum,	Carex sylvatica,
Bartsia viscosa,	C. ovalis,
Habenaria chlorantha,	Arundo phragmites,
Sparganium minimum,	Equisetum limosum.

It must be borne in mind that many common plants are omitted from the foregoing list, because they are species which occur on all Irish mountains, and their vertical range in this district has been already exhibited.

With regard to the Saxifrages of Brandon, the form *S. cæspitosa* (Linn.) does not occur, nor were any specimens gathered approaching it nearly so closely as those from Connemara of last year. The commonest form of Brandon is *S. decipiens*, Sm. in the higher alpine situations; lower down and in richer ground this varies into *S. affinis*, Don. True *S. hypnoides*, nor its closest ally *S. sponheimica*, do not occur.

II.

The Knockmeildown and Commeragh mountains lie in the northern portion of the county Waterford, the former on the western boundary and partly in Tipperary, the Commeraghs east and north of these lie entirely in Waterford.

I visited these mountains in 1882 and again in 1883. Both groups lie in District II. of the *Cybele Hibernica*. The Knockmeildown, which rise to a height of 2609 feet, are monotonous in aspect, and have little interest for a botanist. The Commeraghs are picturesque in the extreme, and well worth a visit. They consist chiefly of an elevated plateau broken down on all sides in steep and frequently inaccessible precipices, with many lakes nestling in the Cooms, which give their names to the group, at their bases. The highest point is 2597 feet. Both ranges are composed chiefly of sandstone and conglomerate of Old Red Sandstone Period, shales and slates of Silurian age occurring sparingly.

These mountains lie within a short distance of the Galtees, which are some four hundred feet higher; they are from ten to twenty miles south of this range, and lie in the same latitude as Brandon, about two degrees westwards. An account of the botany of the Galtee mountains has been already given by me (*Proceedings*, vol. iii. p. 392). Unless affording some additional information or illustration, I have

omitted the re-enumeration of those ubiquitous lowland species which ascend to the summit of all mountain ranges in Ireland.

These mountains did not seem entitled to any very detailed examination, and I did not do much more than satisfy myself with regard to their alpine flora, and the range of the more constantly limited species, as well as note unusual occurrences. The scarcity or absence of *Erica tetralix* is noteworthy.

The alpine species are—

Sedum rhodiola,
Saxifraga stellaris,
Hieracium anglicum,
Vaccinium vitis idæa,
Salix herbacea,
Carex rigida,
Isöetes lacustris.

Of Watson's northern type are—

Saxifraga sponheimica,
Crepis paludosa,
Pinguicula vulgaris,
Empetrum nigrum,
Listera cordata;

while *Saxifraga umbrosa* finds here its most eastern British station. Most of these have not been recorded from the mountains of this county before. *Hieracium anglicum*, *Listera cordata*, *Carex rigida*, and *Isöetes lacustris* are new to the district.

Table of heights to which mountain plants ascend on the Knockmeildown and Commeragh mountains, county Waterford, arranged in descending order.

Knockmeildown mountain, 2600 feet.

Saxifraga umbrosa, Linn. To 2080 feet; on Commeraghs from 2200 to 1100 feet below Coumshingaun Lough, and 500 feet east of Coumduala Lough.

The same, 2530 feet.

Saxifraga sponheimica, Gm. To 2450 feet; on Commeraghs from 1200 to 1100 feet below Coumshingaun Lake.

Campanula rotundifolia, Linn.

Salix herbacea, Linn. Scarce here; abundant on Commeraghs, especially on cliffs looking north around the southern skirts of the Stilloge coom, at 2100 feet; 2050 feet above Coumshingaun Lough.

Poa annua, Linn.

Hymenophyllum unilaterale, Willd. To about 2000 feet; on the Commeraghs more common, 2150 to 1000 feet below Coumshingaun Lough.

The same, 2450 feet.

Empetrum nigrum, Linn. To 2000 feet west of Bay Lough; 2150 in Commeraghs above Stilloge Lakes, and 2300 above Coumshingaun Lake.

Carex rigida, Good. Scarce here; abundant on the Commeraghs at 2100 to 2200 above Stilloge Lakes, and at 2050 above Coumshingaun Lake.

Commeraghs, 2450 feet.

Lycopodium selago, Linn. And at 2000 feet west of Bay Lough, Knockmeildown.

Commeraghs, 2300 feet.

Calluna vulgaris, Salisb.
Vaccinium myrtillus, Linn.
Jasione montana, Linn. South of Stilloge, scarce.
Leontodon autumnalis, Linn. Common at lower elevation.
Eriophorum vaginatum, Linn. ,, ,,
Narthecium ossifragum, Linn. ,, ,,
Luzula sylvatica, Beck.
L. campestris, D.C.
Juncus squarrosus, Linn.
Carex binervis, Sm.

Knockmeildown, 2180 feet.

Orchis maculata, Linn.
Aira flexuosa, Linn.

Commeraghs, 2150 feet.

Vaccinium vitis idæa, Linn. Cliffs looking north above the Stilloge Lakes, the most southern locality in Ireland.
Pedicularis sylvatica, Linn.
Melampyrum pratense, Linn.
Carex pilulifera, Linn.

Knockmeildown, 2060 feet.

Erica cinerea, and at 2000 feet at head of River Tay, Commeraghs.

Commeraghs, 2000 feet.

Ranunculus repens, Linn.
R. acris, Linn.
Angelica sylvestris, Linn.
Saxifraga stellaris, Linn. And at 1420 feet, eastwards from Coumduala Lough.
Valeriana officinalis, Linn.
Taraxacum dens-leonis, Desf.

Knockmeildown, 1930 feet.

Pyrus aucuparia, Gœrt. In several places on ranges lower down.

Commeraghs, 1900 feet.

Sedum rhodiola, D.C. Cliffs above Coumshingaun Lake.
Chrysosplenium oppositifolium, Linn. East of Coumduala Lake.
Crepis paludosa, Moench. With the last, and again at 1420 feet; also by the Tay river lower.
Hieracium anglicum, Fries. Cliffs above Coumshingaun Lake; only locality.
Rhinanthus crista-galli, Linn. Casually transported.
Cystopteris fragilis, Bernh. Cliffs above Coumshingaun Lake; only locality.
Asplenium trichomanes, Linn. Frequent, and taking the place here of *A. viride*.
Polypodium vulgare, Linn.

Commeraghs, 1800 feet.

Listera cordata, R. Br. Slopes looking north above old road between Coumduala and Coumgorra; also at 1350 feet above Coumshingaun Lake on north-looking slopes, and at 1030 feet at Bay Lough in Knockmeildown.

Commeraghs, 1760 feet.

Hypericum pulchrum, Linn. Coumshingaun.
Oxalis acetosella, Linn. ,,
Solidago virgaurea, Linn. Near Coumduala Lake.

Commeraghs, 1720 feet.

Pteris aquilina, Linn. Upper limit on Knockmeildown, 1650 feet.

Commeraghs, 1540 feet.

Litorella lacustris, Linn. Coumduala Lake.
Isöetes lacustris, Linn. ,,

Knockmeildown, 1480 feet.

Ulex gallii, Planch.

Commeraghs, 1470 feet.

Stellaria holostea, Linn. Coumshingaun.
Lychnis flos-cuculi, Linn. Coumduala.

Commeragh, 1420 feet.

Lychnis diurna, Sibth.
Cotyledon umbilicus, Linn.
Epilobium montanum, Linn.

Knockmeildown, 1330 feet.

Bartsia odontites, Huds.
Digitalis purpurea, Linn.

Commeraghs, 1250 feet.

Ranunculus heterophyllus, Sibth.	Coumshingaun,	by the lake.
R. tricophyllus, Chaix.	,,	,,
Sedum anglicum, Huds.	,,	,,
Alchemilla arvensis, Scop.	,,	,,
Peplis portula, Linn.	,,	,,
Rumex obtusifolius, Linn.	,,	,,
Scirpus setaceus, Linn.	,,	,,

Knockmeildown, 1230 feet.

Lastræa æmula, Brack. Above Clogheen road on its west side; Commeragh, below Coumduala, at 700 feet.

Knockmeildown, 1130 feet.

Polygala vulgaris, Linn.	Above Bay Lough.
Holcus lanatus, Linn.	,,
Triodia decumbens, Beauv.	,,
Carex panicea, Linn.	,,
C. paniculata, Linn.	,,
Blechnum boreale, Sm.	,,

Knockmeildown, 1000 feet.

Vicia sepium, Linn. Bay Lough.
Lathyrus macrorrhizus, Wimm. South slopes north-east of Mount Melleray.
Lotus major, Scop. Bay Lough.
Callitriche hamulata, Kutz. ,,
Menyanthes trifoliata. Above Mount Melleray to the north-east.
Rumex nemorosa, Schr. ,, ,,
Quercus robur, Linn. Above Mount Melleray.
Sparganium minimum, Fries. Bay Lough.
Potamogeton natans, Linn. ,,
Osmunda regalis, Linn. Above Mount Melleray.

N.B.—At this elevation cultivation appears on the southern slopes of Knockmeildown.

Commeraghs, 700 feet.

Drosera rotundifolia. Linn. By Coumduala stream.
Hypericum elodes, Linn. ,,
Pinguicula vulgaris, Linn. ,,
Veronica scutellata, Linn. Valley of Tay river.
Scutellaria minor, Linn. ,,

Commeraghs, 600 feet.

Ajuga reptans, Linn. By stream out of Coumduala.
Lastræa oreopteris, Presl. ,,

N.B.—The saxifrages and hawkweeds are easily disposed of here; there is only one of the tufted or *S. hypnoides* form, i. e. *S. sponheimica*, Gm., to which Mr. Baker refers it. This is the usual plant in the north-east of Ireland, and is not alpine in distribution as the "*hirta*" group usually is. *S. umbrosa* is the form *serafolia*; the only hawkweed is *H. anglicum*.

III.

The range of Mount Leinster and the Blackstairs runs north-north-east and south-south-west between the valleys of the Slaney on the east and the Barrow on the west, and forms for some distance the boundary between the counties Wexford and Carlow. It is intersected by one principal pass, that of Scullogue Gap, which separates Mount Leinster on the north from the Blackstairs portion to the south. Mount Leinster is chiefly composed of granite and metamorphic rocks; and its rounded surfaces, devoid of cliffs and cliff-bound cooms, are quite unsuitable for alpine plants. The highest points reached are 2610 feet on Mount Leinster, and 2409 on Blackstairs. The latter is also formed of metamorphic rocks; along an outcrop of bleak schist near the summit *Vaccinium vitis idæa* occurs. This and *Carex rigida*, which grows also on Mount Leinster, are the only alpine species. Neither have been recorded from these mountains before.

The following are additions to the flora of District 3, as it appears from the *Cybele* and its Supplement:—

Pyrus acuparia,	*Carex rigida*,
Veronica scutellata,	*C. lævigata*,
Vaccinium vitis idæa,	*C. riparia*.

These mountains are so isolated and have so little upper shelter that the strongest growing species alone prevail above. It is worthy of notice that the two alpine species and a few other mountain plants appear to grow only on the western sides of the summits, as if to escape the east winds from the channel, or perhaps I should say, to benefit by the moister winds from the west.

Mount Leinster, 2600 feet.

Galium saxatile, Linn.
Calluna vulgaris, Salisb.
Vaccinium myrtillus, Linn.

Empetrum nigrum, Linn. Same range as *Carex rigida* on both mountains.
Rumex acetosella, Linn.
Juncus squarrosus, Linn.
Luzula sylvatica, Bichen.
L. campestris, D.C.
Eriophorum vaginatum, Linn.
E. polystachyum, Linn.
Carex rigida, Good. To 2300 ; and on Blackstairs from 2400 to 2280 feet on west side, not descending eastwards.
Festuca duriuscula, Linn.
Agrostis vulgaris, With.
Lastræa dilatata, Presl.
L. filix-mas, Presl. (var. *abbreviata*).
Hymenophyllum unilaterale, Willd. And at 1900 feet at Blackstairs; to 1800 feet on Mount Leinster.
Lycopodium selago, Linn.

Blackstairs, 2300 feet.

Vaccinium vitis idæa. To 2100 feet : on western slopes from summit, not descending eastwards.

Blackstairs, 2200 feet.

Polypodium vulgare, Linn.

2100 feet.

Carex stellulata, Good. Mount Leinster.
Solidago virgaurea, Linn. Blackstairs, to 18J0 feet.
Carex pilulifera, Linn. ,, ,,
Lycopodium selago, Linn. ,, ,,

Blackstairs, 1900 feet.

Pyrus acuparia, Gœrt.
Erica cinerea, Linn. Barely ascends to this height.

Mount Leinster, 1750 feet.

Pteris aquilina, Linn. On the south side; ceases at 1550 on north side; upper limit at 1650 on Blackstairs.

Blackstairs, 1650 feet.

Hieracium pilosella, Linn.

Blackstairs, 1450 feet.

Ulex gallii, Planch. West side.
Veronica officinalis, Linn. ,,
Cotyledon umbilicus. Linn. ,,

Blackstairs, 1100 feet.

Scilla nutans, Sm. West side.
Lastræa oreopteris, Presl. At 500 feet on Mount Leinster.

The same, 1000 feet.

Ranunculus hederaceus, Linn. West side.
Erica tetralix, Linn. ,,
Myosotis cæspitosa, Sch. ,,

Blackstairs, 850 feet.

Eleocharis multicaulis, Sm. On the west side to 600 feet; also on north of Mount Leinster at 550 feet; a scarce plant in the east of Ireland.

The same, 700 feet.

Drosera rotundifolia, Linn.

Mount Leinster, 500 feet.

Hypericum elodes, Linn. At North-east base.
Lotus major, Scop. ,,
Carex lævigata, Sm. ,,

Between Borris and the base of Blackstairs I observed the following rather local species :—*Erigeron acris*, *Linaria minor*, *Stachys arvenis*, *Linaria vulgaris*, *Lastræa oreopteris*, and *Scutellaria minor*. White foxglove was met with. Along the railway I noted *Equisetum maximum*, and *Lychnis vespertina*; near Goresbridge, and in a large bog near Milford, *Carex riparia*.

IV.

In July, 1883, I spent a few days amongst the Mourne Mountains, and made also an excursion over the Carlingford Hills. These mountains are almost entirely formed of granite, and their rounded slopes, devoid of considerable cliffs and frequently devoid also of soil and moisture, are unfavourable for the growth of plants. Although intersected by an arm of the sea, the Carlingford Hills are geologically and botanically a continuation of the Mourne Mountains.

The Mourne Mountains cover an elliptic area, lying north-east and south-west, of about 15 miles by 6. Several summits rise in isolated hummocky masses throughout the region, of which Slieve Donard (2796), Slieve Commedagh (2512), and Slieve Bingian (2449), are the highest, and lie to the north-east end of the range. The range lies in lat. 54° 2′ to 54° 14′, and W. long. 5° 51′ to 6° 7′. Considering their position and height, they are remarkable for the scarcity of alpine and mountain plants occurring. By the Annalong river several

local species occur plentifully, but they are not plants of mountain districts. Again, the wooded river banks in Tollymore Park contain some interesting hawkweeds, but the mountain lakes are most unproductive, as they usually are in granite districts, whereas in other formations the cliffs surrounding these usually yield some alpine rarities.

Plants of the Mourne and Carlingford Mountains, arranged in descending order :—

Slieve Donard, 2796 feet.

Viola sylvatica, Fries.
Galium saxatile, Linn.
Potentilla tormentilla, Linn.
Empetrum nigrum, Linn. To 1800 feet on Eagle Mountain.
Calluna vulgaris, Salisb.
Vaccinium myrtillus, Linn.
Salix herbacea, Linn. On Slieve Bingian, Slieve Bearnagh, and Slieve Commedagh; lowest on Carlingford at 1850.
Carex pilulifera, Linn.
Festuca ovina, Linn.
Luzula sylvatica, Bich.
Lycopodium alpinum, Linn. On Slieve Commedagh and Slieve Bearnagh; lowest at 2000 on Carn Mountain.

Slieve Commedagh, 2450 feet.

Vaccinium vitis idæa, Linn. Lower limit at 1800 feet on Slieve Bearnagh, and 1900 feet on Slieve Donard.
Campanula rotundifolia, Linn.

Slieve Commedagh, 2350 feet.

Saxifraga stellaris, Linn. To 2000 feet.
Luzula campestris, D.C.
Scirpus cæspitosus, Linn.

Slieve Bearnagh, 2310 feet.

Leontodon autumnalis, var. *taraxica*, Sm.
Solidago virgaurea, Linn. 1500 feet on Carlingford, &c.
Melampyrum pratense, Linn.
Polypodium vulgare, Linn.
Aspidium dilatatum, Sw.
Lycopodium selago, Linn. Descends to 1500 feet on Carlingford, and 1100 feet on Slieve Martin.

Slieve Commedagh, 2250 feet.

Carex sp. not in flower on north side; probably *C. flava*, Linn. (not *C. rigida*).

Polypodium phegopteris, Linn. To 1300 feet on Slieve Maganmore; also on Slieve Donard, and Carlingford at 1900 feet; Shanlieve, 1800 feet.
Blechnum boreale, Sw.

Slieve Donard, 2050 feet.

Thymus serpyllum, Linn. And at 2000 on Slieve Bingian.
Erica cinerea, Linn.

Slieve Commedagh, 2020 feet.

Lycopodium selaginoides, Linn. Frequent, and descends to near sea level by Annalong river; occurs at 1900 feet to 1000 feet on Carlingford.

Slieve Commedagh, 2000 feet.

Listera cordata, R. Br. And at 1500 feet on Carlingford and Slieve Commedagh.
Juniperus nana, Linn. And from 1900 feet to 1600 feet on Slieve Commedagh.

Slieve Donard, 1930 feet.

Pyrus aucuparia, Gœrt.
Hieracium anglicum, Fr. And at 1500 feet on Carlingford.

Eagle Mountain, 1850 feet.

Erica tetralix, Linn. To 1800 feet on Carlingford, and 1850 on Carn Mount.
Juncus squarrosus, Linn.
Eriophorum vaginatum, Linn.
E. polystachyum, Linn.
Aira caryophyllea, Linn.

Slieve Maganmore, 1750 feet.

Hymenophyllum unilaterale, Willd. To 1300 feet.

Carn Mount, 1700 feet.

Pinguicula vulgaris, Linn. And at 1500 feet.

Carlingford, 1700 feet.

Cryptogramme crispa, R. Br. A couple of localities are known to the Rev. Mr. Waddell, of Warrenpoint, who kindly informed me of their whereabouts and sent me fronds. A fern-collector of a different calibre has, I fear, exterminated the species on the Mourne Mountains. He found it and took it away from near the summit of Slieve Bingian (2403) in 1882, where I searched for it without success.
Nardus stricta, Linn.

Carn Mount, 1600 feet.

Ulex gallii, Planch. 1200 feet on Shanlieve.

1550 feet.

Drosera rotundifolia, Linn. Blue Lough, near Slieve Bearnagh. Occurs frequently at 1200 feet.
Potamogeton polygonifolius, Pourr. Blue Lough, near Slieve Bearnagh.
Juncus conglomeratus, Linn. „ „
Potamogeton natans, Linn. Carlingford, in bog-holes.
Carex stellulata, Good. Blue Lough, near Slieve Bearnagh.
C. ovalis, Good. „ „
C. glauca, Scop. „ „

1500 feet.

Cotyledon umbilicus, Linn. Carlingford.
Digitalis purpurea, Linn. „
Hieracium vulgatum, Fries. With beech fern on the north side of Pigeon Rock mountain; another form occurs at 950 feet at Broughnamaddy by the Causeway water.
Carex pulicaris, Linn. Carn Mount.
Asplenium trichomanes, Linn. Pigeon Rock.

Bingian Lake, 1500 feet.

Lobelia dortmanna, Linn. And at 1150 feet in Blue Lough, near Slieve Lamagan.
Litorella lacustris, Linn. With the last in Blue Lough.
Isöetes lacustris, Linn. „

Slieve Commedagh, 1450 feet.

Pteris aquilina, Linn. 1100 feet on Slieve Martin.

Cave Lough, 1450 feet.

Ranunculus flammula, Linn.
Menyanthes trifoliata, Linn.
Carex vulgaris, Fries. And at 1200 feet on Carlingford.
Eleocharis palustris, R. Br.

Slieve Martin, 1400 feet.

Polygala depressa, Wind.
Carex dioica, Linn. At 1150 feet on Carlingford, and frequent at about 1000 feet in the Mourne Mountains.

1320 feet.

Sagina procumbens, Linn. Slieve Martin.
Montia fontana, Linn. „

Callitriche platycarpa, Kutz. Slieve Martin.
Orchis maculata, Linn. ,,
Schœnus nigricans, Linn. Carn Mount.

Slieve Martin, 1250 feet.

Scabiosa succisa, Linn.
Narthecium ossifragum, Linn.
Triodia decumbens, Beauv.

Carlingford, 1150 feet.

Epilobium palustre, Linn.
Prunella vulgaris, Linn.
Veronica scutellata, Linn.
Scirpus fluitans, Hook.
Eleocharis multicaulis, Sm. In a swamp on the northern side of the range *Eleocharis multicaulis* occurs as high as 1100 feet on Slieve Donard, and 1050 on Eagle Mountain.
Carex flava, Linn.
C. ampullacea, Good.

Source of Bann, 1150 feet.

Potamogeton pusillus, Linn.

Below Cove Lough, 1100 feet.

Salix aurita, Linn.

1050 feet.

Ilex aquifolium, Linn. By the waterfall on Mill river, and at the same height on Slieve Donard.
Myrica gale, Linn. Slieve Martin.
Carex binervis, Sm. ,,
Molinia cœrulea, Mœnch. ,,

Slieve Martin, 980 feet.

Anemone nemorosa, Linn.
Rubus saxatilis, Linn.
Rosa tomentosa, Sm.
Leontodon autumnalis, Linn.
Rhinanthus crista-galli, Linn.

Carlingford, 950 feet.

Pinguicula lusitanica, Linn.

Slieve Martin, 920 feet.

Carduus palustris, Linn.
Tussilago farfara, Linn.
Betula alba, Linn.

Spelga, above Woodside, 820 feet.

Ulex europæus, Linn.
Fraxinus excelsior, Linn.
Corylus avellana, Linn.
Scirpus savii, S. et M.

Do., 780 feet.

Veronica serpyllifolia, Linn.

Miner's Hill, Mill River, 600 feet.

Rhynchospora alba, Vall. Rare on these mountains.

In addition to the foregoing, some other observations at lower levels around the mountains may be here given. Starting at Annalong on the sea coast, I followed up the river of that name to the mountains. For five or six miles its course lies in a low, gravelly valley, with plentiful patches of marsh by its side, intermixed with cultivation. The following species were noticed at Annalong:—*Galeopsis versicolor*, *Rosa arvensis*, *Agrostemma githago*, and *Erodium moschatum*. By the stream I gathered in cultivated fields *Vicia hirsuta*, *Stachys arvensis*, *Silene anglica* (frequent), *Scleranthus annuus* (frequent), and at Dunny Water Bridge *Mentha rotundifolia*, but only as a garden escape apparently established on the water's edge. Other local plants were noted between this bridge and Annalong: *Equisetum maximum*, *Lycopodium selaginella*, *Eleocharis pauciflora*, *Carex fulva*, *Achillea ptarmica*, *Gnaphalium sylvaticum*, *Filago minima*, and *Carex lævigata*.

At Narrow Water and between Narrow Water and Warrenpoint I found *Obione portulacoides*, which I have not seen previously north of Drogheda. It was in company with *Statice bahusiensis*.

On the coast north of Newcastle, *Carduus tenuiflorus*, *Lycopsis arvensis*, *Ononis arvensis*, *Gentiana campestris*, *Viola curtisii*, *Filago minima*, *Gnaphalium sylvaticum*, *Lepidium smithii*, *Scleranthus annuus*, and *Pimpinella saxifraga* grow in the flats among the sandhills, and in ditches near *Carex vesicaria* was met with.

In Tollymore Park, by the river banks, I gathered *Lastræa oreopteris*, *Crepis paludosa*, *Veronica montana*, *Milium effusum*, *Euonymus europæus*, *Lastræa æmula*, *Hieracium prenanthoides*, *H. vulgatum* (*sylvaticum*), *H. crocatum*, *H. anglicum*, *H. sabaudum*, *Hymenophyllum unilaterale*, and *Luzula pilosa*.

So far for District 12. The following localities belong to District 5:—It would be more natural to include the Carlingford peninsula with the Mourne Mountains in District 12, and let the north boundary of District 5 run up the river from Dundalk Harbour to the Armagh county. The Mourne and Carlingford Mountains are geologically and botanically inseparable.

On the way up the Carlingford Hills from Omeath, I found the

following:—*Scleranthus annuus*, *Achillea ptarmica*, *Gnaphalium sylvaticum*, and *Stachys arvensis*. In a little shady ravine through which a stream flows, *Crepis paludosa*, *Veronica montana*, *Hieracium prenanthoides*, *H. anglicum*, and *Equisetum sylvaticum* were noted. Farther up, several northern species occurred, which will be found in the body of this report.

The alpine species met with on the Mourne and Carlingford Mountains are—

Saxifraga stellaris,
Hieracium anglicum,
Vaccinium vitis idæa,
Salix herbacea,
Juniperus nana,
Cryptogramme crispa,
Isöetes lacustris,
Lycopodium alpinum,
L. selaginella.

In addition to these, Dr. Dickie has recorded *Arctostaphyllos uva-ursi*, and *Carex rigida* from Slieve Donard, and *Saxifraga aizoides* from Donard Lodge, the latter on Messrs. Thompson and Hyndman's authority. The first two are not, I think, now to be found on Slieve Donard.

Obione portulacoides is an addition to the flora of District 12.

The undermentioned are additions to the flora of District 5:—

Gnaphalium sylvaticum (given in the *Cybele* on "a single plant gathered,")
Hieracium prenanthoides,
H. anglicum,
Salix herbacea,
Listera cordata,
Carex dioica,
Eleocharis multicaulis.

In conclusion, I should mention that Dr. Dickie has given in the introduction to his valuable "Flora of Ulster" a list of plants observed on the summit of Slieve Donard, with a few others arranged in descending order. I have mentioned above the two chief discrepancies between us, which future botanists may be able to harmonize.

V.

My notes on the Derry mountains are the results of a visit to Ben Evenagh and Magilligan in 1882, and a few days spent at Dungiven in 1883, from whence I examined Ben Bradagh, Mullaghmore, and the Sawel and Dart range from Mullaghcarbatagh to Meenard.

Of these groups, the first three lie on the western edge of the Antrim trap-formation, and although of moderate height (Ben Evenagh 1260, Ben Bradagh 1535, and Mullaghmore 1825), their botany is very interesting. That of Ben Evenagh or Magilligan has been famous since as early as 1732, as the curious may read in the *Anthologia Hibernica* for 1794 on the authority of the Bishop of Derry. The late Dr. Moore had also more recently examined this district, when attached

to the Ordnance Survey. The Sawel and Dart mountains are an utterly monotonous and featureless range of wide moors and heather-clad humps of schists, quartzites, and metamorphic limestones, reaching an elevation of 2240 feet at Sawel. This group is usually called the Sperrin Mountains. On the north side of Dart, at 1750 to 1850 feet, is a small area where a few alpines still hold their ground. Elsewhere the common species have it all their own way.

One record of great interest I failed to verify. *Rubus chamæmorus* has its only Irish locality "on the top of Glengana mountain, in the Stranagalwilly range, to the west of Dart, close to the boundary between the counties of Tyrone and Derry," where it was found by Professor Murphy in 1826. I found an old fellow in Stranagalwilly who knew the name Glengana, and directed me to it, which was that part of the range called on the Ordnance map Mullaghclogher. From this I walked the whole range, and searched especially those summits west of Dart, but altogether failed with regard to the cloud-berry. I also made numerous inquiries amongst shepherd lads and others for a berry-bearing plant, which the Rev. Mr. Ross, of Dungiven, has promised to continue for me, and I trust the plant may be re-discovered; but a more unlikely range for any variety in the alpine flora I have not yet set foot on.

Omitting the ubiquitous lowland species which reach all summits, except where there is insufficient soil, I will include all my Derry notes in one Table in descending order. Many lowland species seem capable of extending to a higher zone on the warm and fertile trap rocks: into these I shall go with some detail.

The correspondence between the lingering vestige of an arctic flora met with on Ben Evenagh vegetation, and that I have observed along the trap rocks, a few hundred feet above the sea west of Englishman's Bay, in Disco, in lat. 69° 15′, struck me forcibly, and is, I think, worthy of quoting. Thus, the following are characteristic and common to both localities:—

Saxifraga oppositifolia,
Silene acaulis,
Draba incana,
Dryas octopetala,
Plantago maritima;

while *Alsine verna*, *Saxifraga sponheimica*, *Plantago maritima*, and *Campanula rotundifolia* have their closely allied representation in the arctic station, viz. *Alsine biflora*, *Saxifraga cæspitosa*, *Campanula rotundifolia*, var. *linifolia*; and this enumeration comprises the major part of the flora of the two stations quoted. This coincidence at so vast a distance across the ocean (seventeen or eighteen hundred miles) illustrates at once the source of our arctic flora, and the geological instincts of some of its members. Some of these plants as *Dryas alsine* and *Silene*, &c., also thrive on limestone, and whether there be a similar constitution in the derivative soils is a question of interest. I believe it is the presence of highly alkaline zeolites in the friable

and easily-decomposed siliceous basalt that renders the soil of the trap so fertile. It is thus explained by an early writer, G. B. Sampson, in his Survey of Londonderry. The following is a list of the alpine species observed :—

Draba incana,
Silene acaulis,
Dryas octopetala,
Saxifraga stellaris,
S. oppositifolia,
Hieracium anglicum,
Vaccinium vitis idæa,
Salix herbacea,
Carex rigida,
Lycopodium selaginoides.

Of these, *Saxifraga stellaris* and *Carex rigida* were found in Tyrone, and are therefore additions to District 10. The latter (from Sawel station) is also an addition to District 12. *Listera cordata* was also added to the flora of District 10.

General List of Plants found on the Derry Mountains arranged in Descending Order, the Ubiquitous Species being Omitted.

Sawel, 2200 feet.

Carex rigida, Good. to 1730; also at 1850 feet on Dart, and at 1780 feet on Mullaghclogha.

Mullaghclogha, 2000 feet.

This was the summit which appeared most likely for *Rubus chamæmorus*, and agreed best with the description. Its summit is a wet tussocky bog of *Erica cinerea*, *Eriophora*, *Aira flexuosa*, *Agrostis vulgaris*, *Carex binervis*, and *C. rigida*. I searched it and its western shoulders for the cloud-berry in vain.

Dart, 1850 feet.

Carex pilulifera, Linn.
Lycopodium alpinum, Linn.

Mullaghclogha, 1800 feet.

Cardamine pratensis, Linn.
Viola palustris, Linn.
Montia fontana, Linn.
Erica tetralix, Linn.
Myosotis cæspitosa, Shultz.
Carex stellulata, Good.
Lycopodium selago, Linn. Mullaghmore at 1700 feet.

Dart, 1780 feet.

Saxifraga stellaris, Linn.

Salix herbacea, Linn. A large variety on Mullaghmore at 1750 feet on the trap rocks. This is, I was informed, Clontygearagh mountain, which is the name of the mountain from whence Dr. Moore recorded this willow at 1100 feet. It is called also Craignashaugh, and is part of the White Mountain.

Mullaghclogha, 1770 feet.

Listera cordata, Linn. The two commonest Lastræas, polypody and broadfern, occurred also.

Mullaghmore (Clontygearagh ?), 1770 feet.

Antennaria dioica, Gaert. Benbradagh, 1450 feet.
Campanula rotundifolia, Linn.
Vaccinium vitis idæa, Linn. Somewhat higher on Dart, and descending to 1100 feet in the upper valley of the Altnaheglish river; also on Mullaghclogher at 1750 feet, and Benbradagh at 1450 feet.

Mullaghmore, 1750 feet.

Hieracium anglicum, Fries. Benbradagh from 1500 to 1400 feet. Ben Evenagh, 1100 feet.
Prunella vulgaris, Linn., on trap rock.
Botrychium lunaria, Linn., on trap rock.

Mullaghmore, 1740 feet.

Hieracium vulgatum, Fries. A very stunted form, and should, perhaps, be called *H. gothicum*. The typical *H. sylvaticum* occurs by the Owenrigh river in several places. The species under consideration occurs on Ben Bradagh from 1450 to 1340 feet.

1700 feet.

Alchemilla vulgaris, Linn. Mullaghmore, on trap rock.
Carduus lanceolatus, Linn. ,, ,,
Bellis perennis, Linn. ,, ,,
Thymus serpyllum, Linn. ,, ,,
Empetrum nigrum, Linn. Mullaghclogha. To 1130 feet, near Mullaghmore to north-east.
Juncus supinus, Moend. Sawel.
J. conglomeratus, Linn. ,,

Sawel, 1650 feet.

Pinguicula vulgaris, Linn.

Ben Bradagh, 1530 feet.

Veronica officinalis, Linn. On the trap.
Euphrasia officinalis, Linn. ,,

Do. 1500 feet.

Pyrus aucuparia, Gaert.
Lathyrus macrorrhizus, Wimm.
Lotus corniculatus, Linn. On trap only at this elevation: Ben Evenagh at 1100 feet.
Gentiana campestris, Linn. ,, ,, ,,

Sawel, 1480 feet.

Solidago virgaurea, Linn.
Quercus robur, Linn.

Benbradagh, 1450 to 1400 feet and lower.

The following list of plants will show what an effect the warm soil produced by the decomposition of trap rocks has in modifying the severity of climate due to this altitude without shelter. Samples of these occurred higher on the Sawel range, but only casually, not as members of a regularly elevated lowland flora:—

Ranunculus acris,
R. flammula,
Anemone nemorosa,
Cardamine hirsuta,
Viola sylvatica.
Sagina procumbens,
Cerastium triviale,
Linum catharticum,
Oxalis acetosella,
Hypericum pulchrum,
Trifolium repens,
Ulex europaeus.
Fragaria vesca,
Rosa pimpinellifolia,
Crataegus oxyacantha,
Scabiosa succisa,
Heracleum sphondylium,
Angelica sylvestris,
Senecio jacobæa,
Bellis perennis,
Taraxacum dens leonis,
Achillea millefolium,
Veronica serpyllifolia,
V. chamædrys,
Rhinanthus crista-galli,
Pedicularis sylvatica,
Primula vulgaris,
Salix repens,
Plantago lanceolatus,
Carex vulgaris,
Aira praecox,
Triodia decumbens,
Asplenium trichomanes.

Several others have already appeared from a greater elevation on Mullaghmore, and a few species call for remark.

Alsine verna, Jacq. And from 1100 on Ben Evenagh to 400 feet at Magilligan.
Saxifraga hypnoides, Linn. (var. *sponheimica*). Descends to 1000 feet, and from 1150 to 1000 feet on Ben Evenagh.

Proceeding with the descending list, we shall find the effect of the basaltic soil marked in many instances.

Benbradagh, 1350 feet.

Carduus palustris, Linn. Trap rocks.
Narthecium ossifragum, Linn. ,,

Mullaghcarbatagh (west end of Skerries), 1350 feet.

Epilobium palustre, Linn.
Veronica scutellata, Linn.
Myrica gale, Linn.
Potamogeton polygonifolius, Pour.

Benbradagh, 1300 feet.

Rubus fruticosus (var. *corylifolius*), Sm. Trap rocks.
Hieracium pilosella, Linn. ,,
Euphorbia helioscopia, Linn. ,,
E. peplus, Linn. ,,

Mullaghmore, 1300 feet.

Pinguicula vulgaris, Linn.

Benbradagh, 1250 feet.

Digitalis purpurea, Linn.

Sawel, 1200 feet.

Salix aurita, Linn.

Ben Evenagh, 1150 feet.

Draba incana, Linn. Re-appearing at sea level.
Sedum anglicum, Linn. ,, ,,
Carex pulicaris, Linn.

This mountain is only four or five miles from the sea, and the intermediate ground is chiefly barren of sandhills. The trap escapement looks west. The conditions as regards plant-life are almost those of a sea cliff.

Ben Evenagh, 1150 to 1100 feet, upper limits.

Silene maritima, With. And at sea level.
S. acaulis, Linn. Descending to 950 feet.
Cerastium semidecandrum, Linn.
Trifolium pratense, Linn.
Anthyllis vulneraria, Linn.
Dryas octopetala, Linn.
Saxifraga oppositifolia, Linn.
Hedera helix, Linn.
Senecio vulgaris, Linn.
Hieracium murorum, Linn.

Plantago coronopus, Linn.
P. maritima, Linn.
P. major, Linn. Introduced along sheep-walks.
Urtica dioica, Linn. ,,
Carex panicea, Linn.
Asplenium ruta-muraria, Linn.
Blechnum boreale, Sm.

Mullaghmore, 1130 feet.

Drosera rotundifolia, Linn. By the head of Altnagleis stream.
Lonicera periclymenum, Linn. ,, ,,
Ilex aquifolium, Linn. ,, ,,
Pteris aquilina, Linn. ,, ,,

Corn is grown at or near 1000 feet in several parts of the county This is about the upper limit of cultivation.

Benbradagh, 1000 feet.

Galium palustre, Linn.
Veronica montana, Linn.
Rumex obtusifolius, Linn.
Poa fluitans, Scop.
Equisetum arvense, Linn.

Do., 850 feet.

Lysimachia nemorum, Linn.
Lycopodium selaginoides, Linn.

Mullaghmore, 840 feet.

Fraxinus excelsior, Linn.
Betula alba, Linn.
Corylus avellana, Linn.
Lastræa oreopteris, Linn.

Sawel, 800 feet.

Alnus glutinosa, Goert.

Ben Evenagh, 700 feet.

Viola tricolor, Linn.
Parnassia palustris, Linn.
Achillea ptarmica, Linn.
Chrysanthemum segetum, Linn.
Galeopsis tetrahit, Linn.
Stachys palustris, Linn.
Rumex sanguineus, Linn.
Eleocharis multicaulis, Sm.

Benbradagh, 650 feet.

Ajuga repens, Linn.
Populus tremula, Linn.

Benbradagh, 550 feet.

Prunus communis, Huds.
Iris pseudacorus, Linn.
Luzula pilosa, Willd.

Do., 500 feet.

Stellaria graminea, Linn.
Crepis palludosa, Moench.
Listera ovata, Linn.
Carex ovalis, Good.
Equisetum sylvaticum, Linn.

Ben Evenagh, 500 feet.

Gnaphalium sylvaticum, Linn. Also by the Roe river.
Artemisia vulgaris, Linn.

In the sandhills below Ben Evenagh and on thickets intervening I gathered *Arum maculatum*, *Equisetum maximum*, *Reseda luteola*, *Phleum arenarium*, *Trifolium arvense*, *Lycopsis arvensis*, *Silene anglica*, and *Carex vulpina*. *Scilla verna* also occurs; while in a marsh near Magilligan Point I met with *Ranunculus lingua*. By the Roe river, between Dungiven and Eden bridge, occurs *Galeopsis versicolor*, *Myrrhis odorata*, *Salix alba*, *Geum rivale*, *Centaurea cyanus*, *Hieracium crocatum*, and *Lotus major*. In Owenrigh glen, *Polystichum aculeatum* is frequent, and I was informed that the beech fern occurs here. Between Dungiven and Feeny *Salix pentandra* was noted, and at Park Hill *Hieracium prenanthoides*.

XVI.—Notes on the Kinematics and Dynamics of a Rigid System in Elliptic Space. By Robert S. Ball, LL.D., F.R.S.

[Read, June 9, 1884.]

If we write the quadriplanar transformation

$$y_1 = (11)\,x_1 + (12)\,x_2 + (13)\,x_3 + (14)\,x_4,$$

$$y_2 = (21)\,x_1 + (22)\,x_2 + (23)\,x_3 + (24)\,x_4,$$

$$y_3 = (31)\,x_1 + (32)\,x_2 + (33)\,x_3 + (34)\,x^4,$$

$$y_4 = (41)\,x_1 + (42)\,x_2 + (43)\,x_3 + (44)\,x^4,$$

we have then the general homographic transformation of a point in space. This is too general to correspond with the displacement of a rigid system in elliptic space, but if we further specialize the transformation by the assumption that it is to be orthogonal, then it will correspond with the most general displacement of the rigid system in elliptic space.

If it be orthogonal, then we have the further conditions

$$x_1 = (11)\,y_1 \;\; (21)\,y_2 \;\; (31)\,y_3 \;\; (41)\,y_4,$$

$$x_2 = (12)\,y_1 \;\; (22)\,y_2 \;\; (32)\,y_3 \;\; (42)\,y_4,$$

$$x_3 = (13)\,y_1 \;\; (23)\,y_2 \;\; (33)\,y_3 \;\; (43)\,y_4,$$

$$x_4 = (14)\,y_1 \;\; (24)\,y_2 \;\; (34)\,y_3 \;\; (44)\,y_4.$$

From these we deduce at once the conditions

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 = y_1^2 + y_2^2 + y_3^2 + y_4^2,$$

and consequently

$$\Omega \equiv x_1^2 + x_2^2 + x_3^2 + x_4^2 = 0$$

is the equation to the absolute.

We thus have the general conditions of movement in elliptic space exhibited in a symmetrical manner.

The absolute is only one member of a family of quadric surfaces, each of which possesses the property that a point thereon before the displacement remains thereon after the displacement. Write the expression

$$U \equiv x_1 y_1 + x_2 y_2 + x_3 y_3 + x_4 y_4.$$

This may be

$$(11)x_1^2 + (22)x_2^2 + (33)x_3^2 + (44)x_4^2 + ((12) + (21))x_1 x_2,$$

or it is equally

$$(11)y_1^2 + (22)y_2^2 + (33)y_3^2 + (44)y_4^2 + ((12) + (21))y_3 y_4.$$

The family of surfaces is accordingly

$$U + \lambda\Omega = 0.$$

In the ordinary case of a rigid system in common space every circular cylinder whose axis is coincident with the screw about which the system is displaced possessed this property. The system $U + \lambda\Omega = 0$ is thus the generalization to elliptic space of the system of circular cylinders.

The same result is obtained in another manner by calculating the distance through which any point x is displaced when conveyed by the transformation to y.

Substitute $x_1 + \lambda y$, &c., for x_1, &c., in the equation of the absolute, and we find

$$x_1^2 + x_2^2 + x_3^2 + x_4^2 + 2\lambda(x_1y_1 + x_2y_2 + x_3y_3 + x_4y_4) + \lambda^2(y_1^2 + y_2^2 + y_3^2 + y_4^2),$$

or

$$\Omega + 2\lambda U + \lambda^2\Omega = 0,$$

whence if θ be the distance, we have

$$\cos\theta = \frac{U}{\Omega}.$$

whence we see that the surfaces of the type

$$U - \Omega\cos\theta = 0$$

possess the property that each of them is the locus of the point conveyed through the same distance θ. In ordinary space we of course notice that the points equidistant from the axis of the screw are conveyed through equal distances.

We can now easily see the conditions that the general displacement shall assume the special type of the vector. Cos θ must then be independent of x, a condition which implies

$$(11) = (22) = (33) = (44) = \cos\theta,$$

and every equation of the type $(12) + (21) = 0$ must be satisfied. We then find that the displacement of every particle of the system is of equal length.

It will be easy by this analytical method to deduce all the general properties of the motion of a rigid system in elliptic space.

If a point is to remain unaltered, then we must have

$$y_1 = \rho x_1, \quad y_2 = \rho x_2, \quad y_3 = \rho x_3, \quad y_4 = \rho x_4,$$

and accordingly,

$$\begin{vmatrix} 11-\rho, & 12, & 13, & 14 \\ 21, & 22-\rho, & 23, & 24 \\ 31, & 32, & 33-\rho, & 34 \\ 41, & 42, & 43, & 44-\rho \end{vmatrix} = 0.$$

This however cannot differ from

$$\begin{vmatrix} 11-\frac{1}{\rho}, & 21, & 31, & 41 \\ 12, & 22-\frac{1}{\rho}, & 32, & 42 \\ 13, & 23, & 33-\frac{1}{\rho}, & 43 \\ 14, & 24, & 34, & 44-\frac{1}{\rho} \end{vmatrix} = 0,$$

because the transformation is orthogonal.

Hence the equation for ρ must be a reciprocal one, and we have accordingly

$$\rho^4 + 4A\rho^3 + 6B\rho^2 + 4A\rho + 1 = 0$$

of the tetrahedron whose vertices are given by the four values of ρ, four of the edges from two pair of generators common to the surfaces $\Omega = 0$ and $U = 0$. Let a_1, a_2, a_3, a_4 be the coordinates of one corner of the tetrahedron corresponding to ρ, so that we have

$$\begin{aligned} (11-\rho)a_1 + 12a_2 + 13a_3 + 14a_4 &= 0, \\ 21a_1 + (22-\rho)a_2 + 23a_3 + 24a_4 &= 0, \\ 31a_1 + 32a_2 + (33-\rho)a_3 + 34a_4 &= 0, \\ 41a_1 + 42a_2 + 43a_3 + (44-\rho)a_4 &= 0. \end{aligned}$$

Let $\beta_1, \beta_2, \beta_3, \beta_4$ be the other corner of the tetrahedron characterized by the circumstance that $a\beta$ is not a generator of Ω, then we have

$$\left(11 - \frac{1}{\rho}\right)\beta_1 + 12\beta_2 + \&c. = 0,$$

and similar equations, as it is obvious that the reciprocal values of ρ

correspond with vertices so related together. $\alpha\beta$ is indeed one of the screws about which the system is translated.

Let θ be the distance along the ray $\alpha\beta$ by which a point is displaced, then if the coordinates of that point be

$$\alpha_1 + \lambda\beta_1, \text{ \&c.},$$

we have

$$\Omega = 2\lambda(\alpha_1\beta_1 + \alpha_2\beta_2 + \alpha_3\beta_3 + \alpha_4\beta_4):$$

making the same substitution in U it reduces to

$$\lambda\left(\rho + \frac{1}{\rho}\right)(\alpha_1\beta_1 + \alpha_2\beta_2 + \alpha_3\beta_3 + \alpha_1\beta_4),$$

whence we obtain finally

$$\cos\theta = \tfrac{1}{2}\left(\rho + \frac{1}{\rho}\right),$$

whence we deduce $$i\theta = \log\rho,$$

so that the *pitch* of the displacement is

$$\frac{\log\rho_1}{\log\rho_2},$$

where ρ_1 and ρ_2 are two not reciprocal roots of the equation

$$\rho^4 + 4A\rho^3 + 6B\rho^2 + 4A\rho + 1 = 0.$$

We may here notice a proof that the surface U passes through the four generators belonging to the tetrahedron. Let α and β be the vertices corresponding to ρ and ρ', then by substitution in U we find

$$\lambda(\rho + \rho')(\alpha_1\beta_1 + \alpha_2\beta_2 + \alpha_3\beta_3 + \alpha_4\beta_4),$$

and in Ω $$2\lambda(\alpha_1\beta_1 + \alpha_2\beta_2 + \alpha_3\beta_3 + \alpha_4\beta_4),$$

but if $\alpha\beta$ be a generator of Ω, then the last line must vanish, and so must the former one also.

If the movement be a vector, then the equation for ρ reduces to the form

$$(\rho^2 - 2\rho\cos\alpha + 1)^2.$$

It is well known that when twists about two given screws are compounded together they will constitute a twist on a single screw, which is a generator of a ruled surface of the fourth order (Lindemann). The laws of the distribution of pitch on the generators of this surface are now to be given.

The simplest way of defining the surface is as the locus of the intersection of the planes

$$\begin{cases} x_1 - x_3 \tan\theta = 0, \\ x_2 - x_4 \tan\phi = 0, \end{cases}$$

with the relation $\sin 2\alpha \sin 2\theta + \sin 2\beta \sin 2\phi = 0$, where

$$\tan\rho = \tan(\alpha + \phi)\tan(\beta + \theta) = \tan(\alpha - \phi)\tan(\beta - \theta) = \text{the pitch.}$$

It is hence easily verified that a ray intersecting two conjugate polars intersects also two screws of equal pitch. This is the generalization for elliptic space of the well-known property of the cylindroid, that a ray cutting a generator at right angles passes also through the equal pitch screws on the surface. This theorem is thus seen to be the survival of the more elegant and symmetrical theorem in elliptic space. In the elliptic space no less than in the ordinary space this theorem has important dynamical applications.

For some time I found a difficulty in tracing in elliptic space the analogue of the well-known property in ordinary space, that the pitches of all the screws on a cylindroid could be augmented by a constant quantity. At length however I noticed that this too was only a survival in ordinary space of a more complete theory in elliptic space.

If two screws be reciprocal, and if p, and p' be their pitches, and x and y the lengths of their two common perpendiculars, then we have

$$\tan x \tan y = \frac{p + p'}{1 + pp'}.$$

If therefore two screws be reciprocal they will continue reciprocal notwithstanding changes in their pitches, provided only that

$$\frac{p + p'}{1 + pp'}$$

remains unaltered.

It is hence easy to show that if all the screws of a cylindroid have their pitches p changed into

$$\frac{p + m}{1 + pm},$$

where m is a constant, then they will still be admissible as a possible pitch distribution. This somewhat remarkable result can be demonstrated with equal facility for a system of the n^{th} order as well as for a cylindroid, and we therefore give the more general demonstration.

If and q be the pitches of two reciprocal screws, then they will continue to be reciprocal if the pitches be changed into

$$\frac{p+m}{1+pm} \text{ and } \frac{q+m}{1-qm}$$

respectively, where m is any quantity whatever. This is obvious from the consideration that the function

$$\frac{p+q}{1+pq}$$

remains unaltered when p and q are replaced by their altered values. If therefore we have two reciprocal systems of screws, and all the pitches of one system p be changed each into $\frac{p+m}{1+pm}$, where m is the same quantity for all the screws, then each screw will continue to be reciprocal to all the screws of the reciprocal screw-complex where each pitch q is replaced by $\frac{q-m}{1-qm}$. It hence follows that all the screws of an n-system will continue to form an n-system if the pitches be all changed by writing, instead of each p, the more general value $\frac{p+m}{1+pm}$.

We may express this in a very interesting manner by the statement that—" If all the pitches of a screw system be homographically transformed, subject to the condition that the pitches of + 1 and − 1 remain naltered, then the modified pitches are also a possible pitch distribution."

We may note that this change cannot affect two polars whose pitches are reciprocal, for, if p and q be reciprocal magnitudes, then so are obviously

$$\frac{p+m}{1+mp} \text{ and } \frac{q+m}{1+qm}.$$

We are now enabled to take a remarkable step in the simplification of the question of pitch distribution on the surface which replaces the cylindroid in elliptic space. We have, as before,

$$p = \tan(\alpha+\phi)\tan(\beta+\theta) = \tan(\alpha-\phi)\tan(\beta-\theta),$$

or, by transformation,

$$p = \frac{\tan\alpha\tan\beta + \tan\theta\tan\phi}{1+\tan\alpha\tan\beta\tan\theta\tan\phi}.$$

Hence we may, without loss of generality, regard the pitch distribution to be expressed in the very simple form

$$p = \tan\theta \tan\phi,$$

for, when we have obtained this pitch distribution we can pass at once to the other by merely making $m = \tan\alpha \tan\beta$.

There is one feature on this surface which the analogy of the cylindroid would hardly have suggested, it is the existence of a pair of screws thereon forming conjugate polars, and of which the pitch is indeterminate; one of these corresponds to $\theta = 0$ and $\phi = 90°$, the other to $\theta = 90°$ and $\phi = 0$.

Much remains to be done before the theory of this surface is complete in its dynamical applications; but I have thought that the points referred to in this Paper are of sufficient interest to justify their communication to the Academy, in anticipation of a more complete treatment of the subject at a future time.

XVII.—TRIGONOMETRICAL NOTES. By A. H. ANGLIN, M.A., F.R.S.E., &c.

[Read, May 26, 1884.]

To prove that

$$\tan^{-1}a_1 + \tan^{-1}a_2 + \tan^{-1}a_3 + \ldots + \tan^{-1}a_n = \tan^{-1}\frac{c_1 - c_3 + c_5 - \ldots}{1 - c_2 + c_4 - \ldots},$$

where $a_1, a_2, a_3, \ldots a_n$ are roots of the equation

$$x^n - c_1x^{n-1} + c_2x^{n-2} - c_3x^{n-3} + \ldots + (-1)^n c_n = 0;$$

and hence to establish the well-known trigonometrical formula

$$\tan(\alpha_1 + \alpha_2 + \alpha_3 + \ldots + \alpha_n) = \frac{c_1 - c_3 + c_5 - \ldots}{1 - c_2 + c_4 - \ldots},$$

where c_r denotes the sum of the products of $\tan\alpha_1$, $\tan\alpha_2$, $\tan\alpha_3$, ... $\tan\alpha_n$, taken r at a time, *without the use of the symbol* $\sqrt{-1}$.

1. Since $$\tan^{-1}A + \tan^{-1}B = \tan^{-1}\frac{A+B}{1-AB},$$

we have $$\tan^{-1}a_1 + \tan^{-1}a_2 = \tan^{-1}\frac{p_1}{1-p_2},$$

where a_1, a_2 are roots of the equation $x^2 - p_1x + p_2 = 0$.

Adding on $\tan^{-1}a_3$ to both sides of this result, we get

$$\tan^{-1}a_1 + \tan^{-1}a_2 + \tan^{-1}a_3 = \tan^{-1}\frac{(p_1 + a_3) - p_2a_3}{1 - (p_2 + p_1a_3)}.$$

But a_1, a_2, a_3 are roots of

$$(x^2 - p_1x + p_2)(x - a_3) = 0,$$

that is, of $$x^3 - (p_1 + a_3)x^2 + (p_2 + p_1a_3)x - p_2a_3 = 0.$$

Hence $$\tan^{-1}a_1 + \tan^{-1}a_2 + \tan^{-1}a_3 = \tan^{-1}\frac{q_1 - q_3}{1 - q_2},$$

where a_1, a_2, a_3 are roots of

$$x^3 - q_1x^2 + q_2x - q_3 = 0.$$

And proceeding in like manner with this result, we shall obtain

$$\tan^{-1} a_1 + \tan^{-1} a_2 + \tan^{-1} a_3 + \tan^{-1} a_4 = \tan^{-1} \frac{r_1 - r_3}{1 - r_2 + r_4},$$

where a_1, a_2, a_3, a_4 are roots of

$$x^4 - r_1 x^3 + r_2 x^2 - r_3 x + r_4 = 0.$$

Now assume

$$\tan^{-1} a_1 + \tan^{-1} a_2 + \tan^{-1} a_3 + \ldots + \tan^{-1} a_n = \tan^{-1} \frac{c_1 - c_3 + c_5 - \ldots}{1 - c_2 + c_4 - \ldots},$$

where $a_1, a_2, a_3, \ldots a_n$ are roots of

$$x^n - c_1 x^{n-1} + c_2 x^{n-2} - c_3 x^{n-3} + \ldots + (-1)^n c_n = 0.$$

Here it will be necessary to distinguish the cases when n is even and when n is odd.

(1) If n be even, the last term in the numerator of the right-hand member of the equation is $(-1)^{\frac{n}{2}-1} . c_{n-1}$, and the last term in the denominator is $(-1)^{\frac{n}{2}} . c_n$. Hence, adding on $\tan^{-1} a_{n+1}$ to both sides of the equation, we shall get

$$\tan^{-1} a_1 + \tan^{-1} a_2 + \tan^{-1} a_3 + \ldots + \tan^{-1} a_n + \tan^{-1} a_{n+1} = \tan^{-1} \frac{A}{B},$$

where

$$A = (c_1 + a_{n+1}) - (c_3 + c_2 a_{n+1}) + (c_5 + c_4 a_{n+1}) - \ldots + (-1)^{\frac{n}{2}-1} (c_{n-1} + c_{n-2} . a_{n+1}) + (-1)^{\frac{n}{2}} . c_n a_{n+1},$$

and $B = 1 - (c_2 + c_1 a_{n+1}) + (c_4 + c_3 a_{n+1}) - \ldots + (-1)^{\frac{n}{2}} (c_n + c_{n-1} . a_{n+1}).$

But $a_1, a_2, a_3, \ldots a_n, a_{n+1}$ are roots of

$$(x^n - c_1 x^{n-1} + c_2 x^{n-2} - \ldots - c_{n-1} . x + c_n)(x - a_{n+1}) = 0,$$

that is, of

$$x^{n+1} - (c_1 + a_{n+1}) x^n + (c_2 + c_1 a_{n+1}) x^{n-1} - (c_3 + c_2 a_{n+1}) . x^{n-2} + \ldots + (c_n + c_{n-1} . a_{n+1}) x - c_n . a_{n+1} = 0.$$

Hence, since n is even,

$$\tan^{-1} a_1 + \tan^{-1} a_2 + \tan^{-1} a_3 + \ldots + \tan^{-1} a_n + \tan^{-1} a_{n+1}$$

$$= \tan^{-1} \frac{t_1 - t_3 + t_5 - \ldots + (-1)^{\frac{n}{2}-1} . t_{n-1} + (-1)^{\frac{n}{2}} . t_{n+1}}{1 - t_2 + t_4 - \ldots + (-1)^{\frac{n}{2}} . t_n},$$

where $a_1, a_2, a_3, \ldots a_n, a_{n+1}$ are roots of

$$x^{n+1} - t_1 x^n + t_2 x^{n-1} - t_3 x^{n-2} + \ldots + t_n x^n - t_{n+1} = 0.$$

(2) If n be odd, the last term in the numerator above referred to is $(-1)^{\frac{n-1}{2}} . c_n$, and the last term in the denominator is $(-1)^{\frac{n-1}{2}} . c_{n-1}$. Hence, proceeding as before, we shall get

$$\tan^{-1} a_1 + \tan^{-1} a_2 + \tan^{-1} a_3 + \ldots + \tan^{-1} a_n + \tan^{-1} a_{n+1} = \tan^{-1} \frac{C}{D},$$

where

$$C = (c_1 + a_{n+1}) - (c_3 + c_2 a_{n+1}) + (c_5 + c_4 a_{n+1}) - \ldots + (-1)^{\frac{n-1}{2}} . (c_n + c_{n-1} . a_{n+1}),$$

and

$$D = 1 - (c_2 + c_1 a_{n+1}) + (c_4 + c_3 a_{n+1}) - \ldots + (-1)^{\frac{n-1}{2}} . (c_{n-1} + c_{n-2} . a_{n+1}) + (-1)^{\frac{n+1}{2}} . c_n a_{n+1}.$$

But $a_1, a_2, a_3, \ldots a_n, a_{n+1}$ are roots of

$$x^{n+1} - (c_1 + a_{n+1}) x^n + (c_2 + c_1 a_{n+1}) x^{n-1} - (c_3 + c_2 a_{n+1}) x^{n-2} + \ldots - (c_n + c_{n-1} . a_{n+1}) x + c_n . a_{n+1} = 0.$$

Hence, since n is odd,

$$\tan^{-1} a_1 + \tan^{-1} a_2 + \tan^{-1} a_3 + \ldots + \tan^{-1} a_n + \tan^{-1} a_{n+1}$$

$$= \tan^{-1} \frac{t_1 - t_3 + t_5 - \ldots + (-1)^{\frac{n-1}{2}} . t_n}{1 - t_2 + t_4 - \ldots + (-1)^{\frac{n+1}{2}} . t_{n+1}},$$

where $a_1, a_2, a_3, \ldots a_n, a_{n+1}$, are roots of

$$x^{n+1} - t_1 x^n + t_2 x^{n-1} - t_3 x^{n-2} + \ldots - t_n x^n + t_{n+1} = 0.$$

Thus the proposition is completely established.

Cor.—Putting $a_1 = \tan \alpha_1$, $a_2 = \tan \alpha_2$, $a_3 = \tan \alpha_3$, $\ldots$ $a_n = \tan \alpha_n$, it follows that

$$\tan (\alpha_1 + \alpha_2 + \alpha_3 + \ldots + \alpha_n) = \frac{c_1 - c_3 + c_5 - \ldots}{1 - c_2 + c_4 - \ldots},$$

where c_r denotes the sum of the products of $\tan \alpha_1$, $\tan \alpha_2$, $\tan \alpha_3$, $\ldots$ $\tan \alpha_n$, taken r at a time—the well-known trigonometrical formula, which is thus established without the use of the symbol $\sqrt{-1}$.

2. The following deductions from the foregoing general theorem may be noticed :—

(1) If $$a_1 = a_2 = a_3 = \ldots = a_n = x,$$

then $$n \tan^{-1} x = \tan^{-1} \frac{c_1 x - c_3 x^3 + c_5 x^5 - \ldots}{1 - c_2 x^2 + c_4 x^4 - \ldots},$$

where c_r now denotes the number of combinations of n things taken r at a time, *i. e.* $\lfloor n \div \lfloor r \lfloor n - r$; and if $x = \tan \theta$,

$$\tan n\theta = \frac{c_1 \tan \theta - c_3 \tan^3\theta + c_5 \tan^5\theta - \ldots}{1 - c_2 \tan^2\theta + c_4 \tan^4\theta - \ldots}.$$

(2) Further, if $x = 1$, we get

$$\tan \frac{n\pi}{4} = \frac{c_1 - c_3 + c_5 - \ldots}{1 - c_2 + c_4 - \ldots}.$$

If n be odd, we have

$$\frac{c_1 - c_3 + c_5 - \ldots + (-1)^{\frac{n-1}{2}} . c_n}{1 - c_2 + c_4 - \ldots + (-1)^{\frac{n-1}{2}} . c_{n-1}} = \tan \frac{n\pi}{4} = (-1)^{\frac{n-1}{2}};$$

and if n be even,

$$\frac{c_1 - c_3 + c_5 - \ldots + (-1)^{\frac{n}{2}-1} . c_{n-1}}{1 - c_2 + c_4 - \ldots + (-1)^{\frac{n}{2}} . c_n} = 0 \text{ or } \infty,$$

according as n is of form $4m$ or $4m + 2$. Thus

$$c_1 - c_3 + c_5 - \ldots + (-1)^{\frac{n}{2}-1} . c_{n-1} = 0, \text{ if } n \text{ be of form } 4m;$$

and $$1 - c_2 + c_4 - \ldots + (-1)^{\frac{n}{2}} . c_n = 0, \text{ if } n \text{ be of form } 4m + 2.$$

3. An interesting theorem of a like nature to the preceding one may appropriately be noticed here.

To show that

$$\tan^{-1} a_1 + \tan^{-1} a_2 + \tan^{-1} a_3 + \ldots + \tan^{-1} a_n = \tan^{-1} \frac{h_1 - h_3 + h_5 - \ldots \infty}{1 - h_2 + h_4 - \ldots \infty},$$

where h_r is the sum of the homogeneous products of $a_1, a_2, a_3, \ldots a_n$, and their powers all of r dimensions.

We have

$$(1-a_1x)^{-1}(1-a_2x)^{-1}(1-a_3x)^{-1}\dots(1-a_nx)^{-1}$$
$$=1+h_1x+h_2x^2+h_3x^3+\dots+h_rx^r+\dots\infty.$$

Putting $x=\pm\sqrt{-1}$ in succession, we find

$$(1-a_1\sqrt{-1})^{-1}(1-a_2\sqrt{-1})^{-1}(1-a_3\sqrt{-1})^{-1}\dots(1-a_n\sqrt{-1})$$
$$=1-h_2+h_4-\dots+\sqrt{-1}\,(h_1-h_3+h_5-\dots),$$

and

$$(1+a_1\sqrt{-1})^{-1}(1+a_2\sqrt{-1})^{-1}(1+a_3\sqrt{-1})^{-1}\dots(1+a_n\sqrt{-1})^{-1}$$
$$=1-h_2+h_4-\dots-\sqrt{-1}\,(h_1-h_3+h_5-\dots).$$

Thus
$$\sqrt{-1}\,\frac{h_1-h_3+h_5-\dots\infty}{1-h_2+h_4-\dots\infty}$$
$$=\frac{(1+a_1\sqrt{-1})(1+a_2\sqrt{-1})\dots(1+a_n\sqrt{-1})-(1-a_1\sqrt{-1})(1-a_2\sqrt{-1})\dots(1-a_n\sqrt{-1})}{(1+a_1\sqrt{-1})(1+a_2\sqrt{-1})\dots(1+a_n\sqrt{-1})+(1-a_1\sqrt{-1})(1-a_2\sqrt{-1})\dots(1-a_n\sqrt{-1})}$$

Again,

$$(1+a_1x)(1+a_2x)(1+a_3x)\dots(1+a_nx)=1+c_1x+c_2x^2+\dots+c_nx^n,$$

where c_r denotes the sum of the products of $a_1, a_2, a_3, \dots a_n$, taken r at a time. Putting $x=\pm\sqrt{-1}$ in succession, we find

$$(1+a_1\sqrt{-1})(1+a_2\sqrt{-1})(1+a_3\sqrt{-1})\dots(1+a_n\sqrt{-1})$$
$$=1-c_2+c_4-\dots+\sqrt{-1}\,(c_1-c_3+c_5-\dots),$$

and $(1-a_1\sqrt{-1})(1-a_2\sqrt{-1})(1-a_3\sqrt{-1})\dots(1-a_n\sqrt{-1})$

$$=1-c_2+c_4-\dots-\sqrt{-1}\,(c_1-c_3+c_5-\dots).$$

Hence
$$\frac{h_1-h_3+h_5-\dots\infty}{1-h_2+h_4-\dots\infty}=\frac{c_1-c_3+c_5-\dots}{1-c_2+c_4-\dots}$$

(the last terms in the numerator and denominator of the right-hand member being $(-1)^{\frac{n}{2}-1}.\,c_{n-1}$ and $(-1)^{\frac{n}{2}}.\,c_n$, or $(-1)^{\frac{n-1}{2}}.\,c_n$ and $(-1)^{\frac{n-1}{2}}.\,c_{n-1}$, according as n is even or odd respectively); and therefore

$$\tan^{-1}a_1+\tan^{-1}a_2+\tan^{-1}a_3+\dots+\tan^{-1}a_n=\tan^{-1}\frac{h_1-h_3+h_5-\dots\infty}{1-h_2+h_4-\dots\infty}.$$

Cor.—Putting $a_1 = \tan \alpha_1$, $a_2 = \tan \alpha_2$, ... $a_n = \tan \alpha_n$, it follows that

$$\tan(\alpha_1 + \alpha_2 + \alpha_3 + \ldots + \alpha_n) = \frac{h_1 - h_3 + h_5 - \ldots \infty}{1 - h_2 + h_4 - \ldots \infty},$$

where h_r denotes the sum of the homogeneous products of $\tan \alpha_1$, $\tan \alpha_2$, $\tan \alpha_3$, ... $\tan \alpha_n$, and their powers of r dimensions—a result of a like type to the trigonometrical one already noticed, and is thus established *without the use* of *De Moivre's theorem.*

4. Putting $a_1 = a_2 = a_3 = \ldots = a_n = x = \tan \theta$, in the preceding result, we may deduce

$$n \tan^{-1} x = \tan^{-1} \frac{h_1 x - h_3 x^3 + h_5 x^5 - \ldots \infty}{1 - h_2 x^2 + h_4 x^4 - \ldots \infty},$$

and

$$\tan n\theta = \frac{h_1 \tan \theta - h_3 \tan^3\theta + h_5 \tan^5\theta - \ldots \infty}{1 - h_2 \tan^2\theta + h_4 \tan^4\theta - \ldots \infty},$$

where h_r now denotes the *number* of homogeneous products of n things of r dimensions, *i.e.* $\lfloor\underline{n + r - 1} \div \lfloor\underline{n - 1}\ \lfloor\underline{r}$.

And further, if $x = 1$, we have

$$\frac{h_1 - h_3 + h_5 - \ldots \infty}{1 - h_2 + h_4 - \ldots \infty} = \tan \frac{n\pi}{4},$$

which $= (-1)^{\frac{n-1}{2}}$ if n be odd, and $= 0$ or ∞ according as n is of form $4m$ or $4m + 2$.

Thus $\quad h_1 - h_3 + h_5 - \ldots \infty = 0$, if n be of form $4m$,

and $\quad 1 - h_2 + h_4 - \ldots \infty = 0$, if n be of form $4m + 2$.

SUPPLEMENT.

1. The theorem

$$\tan(\alpha_1 + \alpha_2 + \alpha_3 + \ldots + \alpha_n) = \frac{h_1 - h_3 + h_5 - \ldots \infty}{1 - h_2 + h_4 - \ldots \infty}$$

may also be obtained in the following way:—We have

$$(\cos \alpha_1 + \sqrt{-1} \sin \alpha_1)(\cos \alpha_2 + \sqrt{-1} \sin \alpha_2) \ldots (\cos \alpha_n + \sqrt{-1}) \sin \alpha_n)$$

$$= \cos(\alpha_1 + \alpha_2 + \alpha_3 + \ldots + \alpha_n) + \sqrt{-1} \sin(\alpha_1 + \alpha_2 + \alpha_3 + \ldots + \alpha_n).$$

But $\cos a + \sqrt{-1}\sin a = \dfrac{1}{\cos a - \sqrt{-1}\sin a} = \dfrac{\sec a}{1 - \sqrt{-1}\tan a}$;

therefore

$$\sec a_1 \sec a_2 \sec a_3 \ldots \sec a_n . \frac{1}{1-\sqrt{-1}\tan a_1} . \frac{1}{1-\sqrt{-1}\tan a_2} \ldots$$

$$\frac{1}{1-\sqrt{-1}\tan a_n} = \cos(a_1+a_2+a_3+\ldots+a_n)+\sqrt{-1}\sin(a_1+a_2+a_3+\ldots+a_n),$$

that is,

$$\sec a_1 \sec a_2 \sec a_3 \ldots \sec a_n \left\{1 - h_2 + h_4 - \ldots + \sqrt{-1}\,(h_1 - h_3 + h_5 - \ldots)\right\}$$

$$= \cos(a_1+a_2+a_3+\ldots+a_n)+\sqrt{-1}\sin(a_1+a_2+a_3+\ldots+a_n).$$

Equating possible and impossible parts, we get

$$\sin(a_1+a_2+a_3+\ldots+a_n) = \sec a_1 \sec a_2 \sec a_3 \ldots \sec a_n\,(h_1 - h_3 + h_5 \ldots),$$

$$\cos(a_1+a_2+a_3+\ldots+a_n) = \sec a_1 \sec a_2 \sec a_3 \ldots \sec a_n\,(1 - h_2 + h_4 - \ldots),$$

and therefore

$$\tan(a_1+a_2+a_3+\ldots+a_n) = \frac{h_1 - h_3 + h_5 - \ldots \infty}{1 - h_2 + h_4 - \ldots \infty}.$$

2. The following results may also be worthy of notice in connexion with the foregoing.

We have $\quad \cos n\theta + \sqrt{-1}\sin n\theta = \cos^n\theta\,(1 + \sqrt{-1}\tan\theta)^n$.

Expanding and equating possible and impossible parts, we get

$$\cos n\theta . \sec^n\theta = B,$$

$$\sin n\theta . \sec^n\theta = D,$$

where

$$B = 1 - c_2\tan^2\theta + c_4\tan^4\theta - \ldots,$$

the last term being

$$(-1)^{\frac{n}{2}} . \tan^n\theta, \text{ or } (-1)^{\frac{n-1}{2}} . n\tan^{n-1}\theta,$$

according as n is even or odd; and

$$D = c_1\tan\theta - c_3\tan^3\theta + c_5\tan^5\theta - \ldots,$$

the last term being

$$n(-1)^{\frac{n}{2}-1} . \tan^{n-1}\theta, \text{ or } (-1)^{\frac{n-1}{2}} . \tan^n\theta;$$

for n even or odd; and c_r denoting the number of combinations of n things taken r at a time, *i.e.* $\underline{|n} \div \underline{|r}\,\underline{|n-r}$.

Again,

$$\cos n\theta + \sqrt{-1}\sin n\theta = (\cos\theta - \sqrt{-1}\sin\theta)^{-n} = \sec^n\theta\,(1 - \sqrt{-1}\tan\theta)^{-n}.$$

Proceeding as before, we find

$$\cos n\theta \cos^n\theta = 1 - h_2\tan^2\theta + h_4\tan^4\theta - \ldots \infty = A, \text{ suppose,}$$

$$\sin n\theta \cos^n\theta = h_1\tan\theta - h_3\tan^3\theta + h_5\tan^5\theta - \ldots \infty = C, \text{ suppose,}$$

where $$h_r = \lfloor n+r-1 \div \lfloor n-1 \lfloor r.$$

Thus we deduce the following relations:—

$$AB = \cos^2 n\theta,$$

$$\frac{A}{B} = (\cos\theta)^{2n},$$

$$CD = \sin^2 n\theta,$$

$$\frac{C}{D} = (\cos\theta)^{2n};$$

and hence

$$\frac{A}{B} = \frac{C}{D}, \text{ or } AD = BC,$$

$$AB + CD = 1,$$

$$CD = AB\tan^2 n\theta,$$

$$4ABCD = \sin^2 2n\theta,$$

$$AC = BD\cos^{4n}\theta.$$

XVIII.—A CATALOGUE OF SUSPECTED VARIABLE STARS. WITH NOTES AND OBSERVATIONS. By J. E. GORE, M. R. I. A., F. R. A. S., Honorary Member of the Liverpool Astronomical Society. With Plate II.

[Read, May 12, 1884.]

THE following Catalogue of Suspected Variable Stars has been compiled from various sources. Many of the stars it contains are doubtless really variable, but the observations hitherto made have not been sufficient to place their variability beyond question. In some cases the variation would seem to be small, with a long period, possibly several years. Others may possibly belong to the Algol type, and from the nature of the light curve the variability may escape detection for a long time. On the other hand, future observations will no doubt show that many of them are constant in their light, and these of course must be removed from future Catalogues. Observations of these less suspicious stars should however not be neglected, as even negative results will be of value as tending to show constancy of light.

In the notes to the Catalogue, I have given the magnitudes assigned to each star by different observers. In many cases there are considerable discrepancies in these magnitudes, which may possibly be due to actual variation in the light of the star. With reference to the value to be assigned to the magnitudes of the earlier observers, the following remarks by Sir W. Herschel, regarding the discrepancies in Flamsteed's magnitudes may be quoted:—"We ought to account for this by allowing that Flamsteed did not compare the stars to each other, but referred each of them separately to its own imaginary standard of magnitude. This is the real source of all such contradiction, which, therefore, cannot be charged to our author. As we should, however, take it for granted that the magnitudes were affixed to the stars with as much care as the nature of an unsettled standard would allow, a short inquiry into the extent of the confidence we may place upon the method of magnitudes will be of considerable use. We have observed that, in this method, the brightness of stars is referred to unsettled standards; but admitting that a pretty general though coarse idea may be formed of these magnitudes, it may be granted that a mistake of a whole order in the first class cannot be supposed. The difference between a star of the first and second magnitude is so palpable that it excludes all suspicion of taking one for the other. When sub-divisions are introduced the case becomes doubtful, 1·2 may easily pass for 2·1. But though

these two notations should not be sufficiently clear to be distinguished from each other, yet I am inclined to believe that the former may be precise enough to point out a difference from 2 m. and the latter from 2·3 m. With the next order of stars the difference is much less striking; but yet 2 m. will convey an idea which may be pretty well distinguished from 3 m. 2·3 m. however, cannot be sufficiently kept apart from 3·2 m., or either of these expressions from 3 m. or from 2 m. Perhaps the former may be distinguished from 3·4 m., and the latter from 4 m. The following step from 3 m. to 4 m., or indeed from 3·4 to 4·5, is less decisive than from 2 m. to 3 m. Again, if a star had changed from 4 m. to 5 m., or from 4·5 to 5·6 since Flamsteed's time, we could hardly entertain more than a very slight suspicion of the alteration. From 4 to 5·6 m., or from 4·5 to 6 m., would be a pretty considerable step, and might serve as a foundation for an argument. A change from 5 m. to 6 m. is such as no stress could be laid upon; and such are the changes from 5·6 m. to 6·7 m., and from 6 m. to 7 m. In all these inferior orders less than an alteration of a magnitude and a half could hardly deserve attention."—(*Phil. Trans.*, 1796, p. 166.)

The above remarks will apply in some degree to the magnitudes assigned by Lalande, Piazzi, Bessel, and other meridional observers. In the case of Flamsteed's observations, however, the discrepancies are so great that I have not quoted his magnitudes.

I have given the magnitudes of the stars, as shown in *Harding's Atlas* (1822), which seems to have been constructed with considerable care.

The magnitudes given by Sufi, Argelander, Heis, Behrmann, and Gould (especially the last named), are more reliable, as they are the results of actual comparisons of the stars, *inter se*.

I have also given the results of Sir W. Herschel's observations (*Phil. Trans.*, 1796, and 1799), the value of which has only very lately been recognized.

The following is an explanation of the symbols used by Sir W. Herschel, as given by him in the *Philosophical Transactions* for 1796, p. 189:—

‘	The least perceptible difference less bright.
·	Equality.
’	The least perceptible difference more bright.
-	A very small difference more bright.
- -	A considerable difference more bright.
- - -	Any great difference, more bright in general.

Compound characters, expressing the wavering of star-light, as follows:—

‘. From the least perceptible difference less bright to equality.

; From equality to the least perceptible difference more bright.

‾, From a very small difference more bright to the least perceptible difference.

=, From -, to - etc.

‘; The wavering expressed by the passing of the light from a state of the least perceptible difference less bright to equality, and to the least perceptible difference more bright.

‾,· The wavering expressed by the change from - to , and to · , or from · to , and to - . Professor Pritchard finds that · = 0·09 mag.; , = 0·19 m., and - = 0·40.

Dr. Gould's magnitudes of the stars, observed at Cordoba, as given in the *Uranometria Argentina*, are of especial value, as they are the results of the independent observations of four observers, and any future change of light in a star to the extent of even half a magnitude can hardly escape detection by careful comparison with neighbouring stars.

A few nebulæ suspected of variation have also been inserted in the Catalogue.

I have added my own observations of a considerable number of the stars in the Catalogue. Those previous to October, 1877, were made in the Punjab, India, and the remainder in Ireland. These observations were chiefly made with a binocular, or field-glass, by Browning, London, having object-glasses of 2 inches diameter, and a magnifying power of about 6 diameters. With this glass, stars to about 9 m., or fainter—when not close to brighter stars—can be readily discerned in a clear sky, in the absence of moonlight. In comparing the relative brightness of stars, I have always found it the best plan to accurately focus the field-glass. Some observers put the glass slightly out of focus in making their observations, and consider that in this way the influence of colour on the eye is, to a great extent, eliminated. With reference to this method, Dr. Gould says (*Uranometria Argentina*, note to *l* Carinæ, p. 252): "The results are not very satisfactory, owing in part to the circumstance that many of the comparisons were made by putting the opera-glass out of focus, a method which our experience

shows not to give results in accordance with estimates made by the method of sequences, or by comparison with artificial stars of measureable brilliancy."

Some astronomers lay great stress on the use of a photometer in the determination of star magnitudes, but the Cordoba observations given in Dr. Gould's great work, the *Uranometria Argentina*, show what good results can be obtained by careful estimation with the naked eye, aided when necessary by an opera-glass, without the use of any photometer whatever. With reference to this method, Sir John Herschel says (*Cape. Obs.*, p. 305): "Without dissuading from the new and the improvement of old instrumental contrivances (or *astrometers*) for this purpose, and having myself attempted it, not as I think without some degree of success, as will be hereafter explained, I am yet disposed to rely mainly for the formation of a real scale of magnitudes on comparisons made by the unassisted judgment of the naked eye."

Of the photometers which have been tried for the purpose, the "wedge photometer," as used by Professor Pritchard, seems to give the most consistent and satisfactory results. A simple and ingenious form of photometer has lately been devised by the Rev. T. E. Espin, a description of which will be found in the *English Mechanic*, vol. xxxvii., p. 384.

I have added Professor Pritchard's magnitudes—obtained with the "wedge photometer"—of those of his stars which are included in my Catalogue. They represent the magnitudes of the stars as supposed to be seen in the zenith, and this fact should be remembered when his magnitudes are compared with those given by other astronomers.

Professor Pritchard's results will be found in vol. xlvii. of the *R.A.S. Memoirs*.

The magnitude given in the *Harvard Photometry* have also been added, and are denoted by the letters H. P.

I have inserted in the Catalogue on my own authority a number of stars which I have suspected of variation, either from my own observations or from the great discrepancies in the magnitudes assigned to them by different observers.

The positions of the stars have been brought up to 1880·0 (the epoch of Mr. Proctor's *Atlas*), the R.A. being given to the nearest second, and the Declination to the nearest decimal of a minute.

In conclusion, my best thanks are due to the Rev. T. E. Espin, B.A., F.R.A.S., President of the Liverpool Astronomical Society, and W. S. Franks, Esq., F.R.A.S., Leicester, for much valuable assistance and information.

A CATALOGUE OF SUSPECTED VARIABLE STARS.

No.	STAR.	R.A., 1880.			Declination, 1880.		Supposed Change of Magnitude.	Authority.
		H.	M.	S.	°	′		
1	γ Pegasi, ...	0	7	3	+ 14	31·0	..	Schwab. / Gould.
2	Near γ Pegasi, . . .	0	6	59	+ 16	15·4	..	Olbers.
3	— Piscium, ...	0	14		+ 2	22	..	Pickering.
4	LL 405–6 Ceti, . . .	0	15	42	– 20	43·4	5·2 to 6·4	Chandler, 1882.
5	— Ceti, ...	0	17	42	– 10	17·5	..	Borelly.
6	β Hydri, ...	0	19	25	– 77	55·8	..	Sir J. Herschel.
7	11 Ceti, ...	0	23	46	– 1	46·7	..	Sir W. Herschel.
8	113 P. O. Ceti, . . .	0	28	22	– 5	12·5	..	Admiral Smyth.
9	L 144 Phœnicis, . . .	0	29	57	– 55	28·9	5·7 to 6·5	Dr. Gould.
10	π Andromedæ, . . .	0	30	28	+ 33	3·5	..	Sir W. Herschel.
11	15 Ceti, ...	0	31	56	– 1	9·8	..	Sir W. Herschel.
12	LL 1013 Cassiopeiæ, . .	0	33	21	+ 51	13·3	5–10	
13	— Andromedæ, . . .	0	36	10	+ 40	36·8	..	Rev. T. W. Webb.
14	201 B.A.C. Cassiopeiæ, .	0	38	28	+ 54	33·8	6–7	Franks.

No.	Star.	R.A., 1880. H.	M.	S.	Declination, 1880. °	′	Supposed Change of Magnitude.	Authority.
15	D.M. 81°, 18 Cephei, . .	0	40	8	+ 81	18·7	..	{ Pickering. Knott.
16	36 Andromedæ, . . .	0	48	31	+ 22	58·8	..	Schmidt.
17	γ Cassiopeiæ, . . .	0	48	50	+ 60	3·9	..	J. Herschel.
18	263 B.A.C. Piscium, . .	0	50	47	+ 26	21·1	..	Franks.
19	η Andromedæ, . . .	0	50	47	+ 22	46·3	..	Schmidt.
20	Near μ Cassiopeiæ, . .	1	0	1	+ 54	1·6	6–0	Smyth.
21	β Phœnicis, ...	1	0	43	− 47	21·7	..	Gould.
22	LL 2037–8 Cassiopeiæ, . .	1	3	24	+ 51	29·5	7–10	
23	LL 2097–8 Piscium, . .	1	4	36	+ 8	55	6–8	Burnham and Gould.
24	ϕ Piscium, ...	1	7	14	+ 23	56·8	Comes var. ?	Smyth.
25	ζ Piscium, ...	1	7	36	+ 6	56·6	4 (?)–6	Webb ?
26	37 Ceti, ...	1	8	21	− 8	34·1	..	Gould.
27	LL 2416 Ceti, . . .	1	14	4	− 16	26·4	..	Jacob, 1857.
28	ξ Andromedæ, . . .	1	15	15	+ 44	54·1	..	Pigott, 1786.
29	D.M. 8°, 215 Piscium, . .	1	15	16	+ 9	3·2	9·5–0	Tempel.
30	43 Ceti, ...	1	16	26	− 1	4·6	6·6–7·3	Gould.
31	— Piscium, ...	1	16	36	+ 14	14·3	..	C. H. F. Peters.

33	LL 2077 Piscium, . . .	1	22	5	− 7	20·4	5·9	Gould.
34	LL 2798 Ceti . . .	1	25	29	− 7	20·2	6·9	Gould.
35	40 Cassiopeiæ, . . .	1	28	57	+ 72	26	4–7	
36	3447 h Sculptoris, . .	1	30	36	− 30	31·3	..	
37	L 468 Eridani, . . .	1	30	45	− 58	45·1	5·9–6·5	Gould.
38	L 480 Sculptoris, . . .	1	33	44	− 29	38·0	..	Gould.
39	42 Cassiopeiæ, . . .	1	33	38	+ 70	1	..	Gore, 1876.
40	Σ 155 Piscium, . . .	1	37	54	+ 8	53·3	7½	Dembowski.
41	54 Ceti, ...	1	44	30	+ 10	27·0	..	Gould.
42	ζ Ceti, ...	1	45	32	− 10	55·7	..	Gould.
43	ε Cassiopeiæ, . . .	1	45	42	+ 63	4·8	..	W. Herschel.
44	55 Andromedæ, . . .	1	46	5	+ 40	8·1	..	Pigott.
45	ξ Piscium, ...	1	47	20	+ 2	35·8	..	
46	V Piscium, ...	1	48	2	+ 8	11·5	6 to 9	Argelander.
47	56 Andromedæ, . . .	1	48	2	+ 36	40·0	..	Cornish.
48	7 Arietis, ...	1	49	9	+ 22	59·5	..	Piazzi.
49	η′ Hydri, ...	1	49	32	− 68	32·1	6·6–7·4	Gould.
50	112 Piscium, . . .	1	53	54	+ 2	31·6	6·0	Schmidt.
51	α Hydri, ...	1	54	59	− 62	9·3	..	J. Herschel.

No.	Star.	R.A., 1880.	Declination, 1880.	Supposed Change of Magnitude.	Authority.
		H. M. S.	° ′		
52	α Piscium, ...	1 55 50	+ 2 11·1	..	
53	L 617 Hydri, . . .	1 56 57	− 63 20·6	7·0 to 7¾	Gould.
54	61 Ceti, ...	1 57 39	− 0 55·0	..	W. Herschel.
55	ν Fornacis, ...	1 59 6	− 29 52·4	..	Gould.
56	α Arietis, ...	2 0 25	+ 22 53·6	..	Gould.
57	55 Cassiopeiæ, . . .	2 5 5	+ 65 57·7	6–8	Houzeau, 1875.
58	66 Ceti, ...	2 6 39	− 2 57·3	6–7	Taylor.
59	L 691 Hydri, . . .	2 9 53	− 66 43·0	6–7½	Gould.
60	LL 4339 Persei, . . .	2 15 29	+ 54 49·2	6·3–8	Talmage, 1880.
61	740 B.A.C. Cassiopeiæ, .	2 20 19	+ 81 6·7	6–8½	Baily.
62	P. II. 89 Trianguli, . .	2 21 19	+ 29 20	6·5	Webb.
63	15 Trianguli, . . .	2 28 30	+ 34 9·8	5–8	
64	79 Ceti, ...	2 29 19	− 4 4·3	6·7	W. Herschel.
65	LL 4831 Ceti, . . .	2 30 14	− 7 12·5	..	Gould.
66	LL 4864 Persei, . . .	2 32 12	+ 49 2·8	6½–9	
67	85 Ceti, ...	2 36 1	+ 10 14·0	5·7	W. Herschel.
68	38 Arietis, ...	2 38 24	+ 11 56·5	4·1	W. Herschel.

70	π Arietis, ...	2	43	36	+ 16	57·0	..	Struve.
71	17 Persei, ...	2	44	5	+ 34	34·2	..	W. Herschel
72	B 51 Cassiopeiæ, . . .	2	46	34	+ 63	50·2	6½–8	Birmingham.
73	L 937 Horologii, . . .	2	49	44	− 63	24·0	6·0–6·7	Gould.
74	21 Persei, ...	2	49	59	+ 31	27·3	..	Gore, 1883.
75	η Eridani, ...	2	50	34	− 9	22·5	..	W. Herschel.
76	47 Arietis, ...	2	51	11	+ 20	11·4	..	W. Herschel.
77	ε Arietis, ...	2	52	21	+ 20	52	4·0–6·0	Struve and Gould.
78	Bradley, 396 Cassiopeiæ, .	2	52	57	+ 81	0·5	4·5–7	
79	5 Eridani, ...	2	53	38	− 2	56·6	..	Rev. T. E. Espin.
80	θ Eridani, ...	2	53	42	− 40	47·2	..	Gould.
81	93 Ceti, ...	2	56	6	+ 3	52·7	5·3	W. Herschel.
82	ρ^3 Eridani, ...	2	56	49	− 8	9·5	Comes var. ?	Burnham.
83	β Persei (comes), . . .	3	0	22	+ 40	29·6	10–14	Schröter and Sadler.
84	12 Eridani, ...	3	6	58	− 29	27·7	4·3	W. Herschel.
85	ζ Arietis, ...	3	8	0	+ 20	36·0	..	Gould.
86	κ′ Ceti, ...	3	13	4	+ 2	55·7	5–6	Franks.
87	χ′ Fornacis, ...	3	21	18	− 36	20·5	..	Gould.
88	z Eridani, ...	3	25	57	− 41	46·5	4·0–6·3	Houzeau, 1875.
89	ε Eridani, ...	3	27	17	− 9	51·8	4·0	W. Herschel.

No.	Star.	R.A., 1880. H. M. S.	Declination, 1880. ° ′	Supposed Change of Magnitude.	Authority.
90	9 Tauri, ...	3 29 54	+ 22 49·1	..	W. Herschel. Baily.
91	8 Eridani, ...	3 37 30	− 10 10·2	..	W. Herschel.
92	Maia Pleiadum, . . .	3 38 41	+ 23 59·8	..	Wolf.
93	Merope Pleiadum, . .	3 39 12	+ 23 34·4	..	Wolf.
94	30 (*e*) Tauri, . . .	3 41 41	+ 10 46·4	5–6	Franks.
95	Atlas Pleiadum, . . .	3 42 2	+ 23 41·2	..	Wolf.
96	ρ Fornacis, ...	3 43 5	− 30 31·8	5·3–6·0	Gould.
97	*f* Eridani, ...	3 44 10	− 37 59·2	..	Gould.
98	LL 7172 Tauri, . . .	3 46 45	+ 7 25·2	6½–8	Gould.
99	L 1286 Eridani, . . .	3 50 11	− 40 42·6	..	Gould.
100	γ Eridani, ...	3 52 26	− 13 51·0	2·5–3·5	Secchi.
101	P III 213 Tauri, . . .	3 53 47	+ 22 51·6	Comes var.	Webb?
102	LL 7737 Eridani, . . .	4 2 59	− 9 0·1	..	Gould.
103	LL 7710 Persei, . . .	4 3 16	+ 33 16·6	..	
104	47 Tauri, ...	4 7 25	+ 8 58	5–6	Franks.
105	48 Tauri, ...	4 8 56	+ 15 6·2	6–7	Schmidt.
106	121 Heis Persei, . . .	4 11 53	+ 49 57·7	5·8–7·7	Pierce.

108	889 II Tauri, . . .	4	14	57	+ 19	14·2	Var. Nebula.	d'Arrest, 1861.
109	θ Reticuli, ...	4	16	20	− 63	32·8	..	Gould.
110	Σ 547 Eridani, . . .	4	19	48	− 1	40	Comes var. ?	Gledhill, 1880.
110A	θ^1 and θ^2 Tauri, . .	4	22		+ 15	42	..	Webb.
111	ν' Eridani, ...	4	28	48	− 30	0·5	4·3–5	Gould.
112	α Tauri, ...	4	29	2	+ 16	16·0	..	{ Secchi. Espin.
113	ν Eridani, ...	4	30	9	− 3	35·9	3·4–5	{ Franks. Gore.
114	Σ 572 Tauri, . .	4	31	4	+ 26	42·5	6·5	Struve.
115	— Eridani, ...	4	32		− 30	38	..	Gore, 1876.
116	53 Eridani, ...	4	32	41	− 14	32·3	..	Gore.
117	54 Eridani, ...	4	35	11	− 19	54·1	4·4–5·2	Gould.
118	— Eridani, ...	4	39		− 18	36	6 to 9	Gore, 1876.
119	π' Orionis, ...	4	43	18	+ 6	45·1	3 to 5	{ Gould, Espin.
120	B 85 Tauri, ...	4	44		+ 28	19·1	7½–10	Birmingham.
121	60 Eridani, ...	4	44	47	− 16	25·6	4·8–5·8	Gould.
122	LL 9167 Eridani, . . .	4	45	42	− 27	8·3	7·8–0	Bond.
123	o' Orionis, ...	4	45	45	+ 14	3·1	5–6	
124	5 Orionis, ...	4	47	7	+ 2	17·8	5·6–6·6	Gould.
125	W.B. 1025 Orionis, . .	4	48	18	+ 7	35·1	6·0–6·4	Gould.
126	π^6 Orionis, ...	4	52	20	+ 1	31·7	3–5	Schjellerup.

No.	Star.	R.A., 1880.			Declination, 1880.		Supposed Change of Magnitude.	Authority.
		H.	M.	S.	°	′		
127	LL 9420 Leporis, . . .	4	53	39	− 16	33·9	5–6	Espin, 1883.
128	LL 9418 Orionis, . . .	4	54	13	+ 3	26·3	6·2	Gould.
129	LL 9462 Orionis, . . .	4	55	39	+ 0	32·8	6·6	Gould.
130	1 Leporis, ...	4	57	41	− 22	58·1	..	
131	— Leporis, ...	4	58	0	− 21	14	6–9	Gore, 1876.
132	ε Leporis, ...	5	0	22	− 22	31·8	..	Gould.
133	LL 9667 Eridani, . . .	5	1	41	− 8	48·7	6·9–8·0	Gould.
134	β Eridani, ...	5	1	58	− 5	14·4	½ a mag.	Gould.
135	λ Eridani, ...	5	3	24	− 8	54·6	4–6	
136	LL 9767 Orionis, . . .	5	5	31	− 0	21·2	7·0	Gould.
137	II B 16 Leporis, . . .	5	6	10	− 12	2·0	5½–7½	{ Espin. { Morton.
138	ρ Orionis, ...	5	7	2	+ 2	43·0	4·6–5·1	Gould.
139	α Aurigæ, ...	5	7	50	+ 45	52·4	..	{ Struve, 1838. { Ellner, 1855.
140	β Orionis, ...	5	8	46	− 8	20·5	..	Gould.
141	16 Aurigæ, ...	5	10	18	+ 33	15·0	..	Franks.
142	B 103 Aurigæ, . . .	5	11	49	+ 39	12·9	..	d'Arrest.
143	109 Tauri, ...	5	12	4	+ 21	58·4	..	Franks.

145	B A C 1661 Orionis,	5	15	48	+ 3	27·1	..	Taylor
146	LL 10159 Orionis,	5	18	39	− 2	36·3	..	Burnham, 1878.
147	γ Orionis,	5	18	42	+ 6	14·4	1·7	Gould.
148	β Leporis,	5	23	6	− 20	51·3	..	J. Herschel.
149	1706 B.A.C. Camelo,	5	23	46	+ 74	58	..	
150	— Orionis,	5	24	3	− 1	7·4	..	Argelander.
151	119 Tauri,	5	25	12	+ 18	30·2	4½–5½	Webb?
152	1727 B A C Aurigæ,	5	25	26	+ 32	12·1	..	Taylor.
153	D.M 41°, 1222 Aurigæ,	5	25	49	+ 41	1	8·6–?	Espin.
154	Anon Tauri,	5	27	41	+ 21	51·6	8½–11½	Schmidt.
155	λ Orionis,	5	28	31	+ 9	51·2	3·5	Gould.
156	L. 1890 Columbæ,	5	28	50	− 35	13·3	..	Gould.
157	42 Orionis,	5	28	57	− 4	55·1	..	Gould.
158	LL 10527 Orionis,	5	29	10	− 6	5·4	5½–7½	Falb. Gould.
159	Anon Orionis,	5	29	36	− 3	19·9	6·7–8	Gould.
160	45 Orionis,	5	29	45	− 4	56·1	..	Gould.
161	Near θ Orionis (822 Bond),	5	29	57	− 5	33·2	9·7–12·8	Schmidt, 1878. Common, 1883.
162	σ Orionis (Comes),	5	32	43	− 2	40·3	..	Baxendell, 1883.
163	α olumbæ,	5	35	18	− 34	8·3	2·4–2·9	Gould.
164	B 118 Orionis,	5	36	3	+ 2	18·4	Var. colour.	Birmingham.

No.	Star.	R.A., 1880. H. M. S.	Declination, 1880. ° ′	Supposed Change of Magnitude.	Authority.
165	B 120 Tauri, . . .	5 37 53	+ 24 22·0	8–9·5	Birmingham.
166	B 121 Geminorum, . .	5 38 30	+ 20 38·1	7–8	Birmingham.
167	132 Tauri, ...	5 41 39	+ 24 31·9	..	Gore.
168	κ Orionis, ...	5 42 4	− 9 42·7	..	Gould.
169	υ Aurigæ, ...	5 42 50	+ 37 16·5	4·3–5·3	Espin.
170	56 Orionis, ...	5 46 13	+ 1 49·5	4·9–5·5	Gould.
171	L 2080 Pictoris, . . .	5 50 20	− 57 10·7	..	Gould.
172	π Aurigæ, ...	5 51 1	+ 45 55·5	..	Secchi.
173	LL 11382, Orionis, . .	5 54 3	− 3 4·7	5·1–5·9	Gould.
174	35 Aurigæ, ...	5 54 58	+ 51 34·5	5·5–8	Dembowski.
175	39 Aurigæ, ...	5 56 24	+ 42 59·2	..	Gore, 1878.
176	L 2145 Pictoris, . . .	6 1 40	− 48 26·9	6–8	Tebbutt, 1881.
177	19 Leporis, ...	6 2 29	− 19 9·2	4–7	Tebbutt, 1883.
178	W B VI 58 Leporis, . .	6 4 8	− 14 33·9	..	Gore, 1877.
179	L 2168 Leporis, . . .	6 5 48	− 26 7·8	5·9–6·4	Gould.
180	LL 11884 Orionis, . .	6 8 20	+ 13 53·1	..	Gould.
181	B 141 Aurigæ, . . .	6 9 21	+ 39 30·7	6·9–8·0	Birmingham.
182	W B 265 Orionis, . . .	6 10 55	+ 5 8·2	6–8	Gould.

183	L.L. 12164 Orionis, . .	6	13	50	− 3	58·7	5·4–5·9	Gould.
184	B 144 Geminorum, . .	6	18	37	+ 14	47·1	6½–8	Birmingham.
185	α Argûs (Canopus), . .	6	21	18	− 52	37·7	1 m.	?
186	B 147 Monocerotis, . .	6	24	26	− 2	56·5	5½–8	Birmingham.
187	12 Monocerotis, . . .	6	25	57	+ 4	56·4	5–6½	Gould.
188	O A 5270 Canis Majoris, .	6	28	7	− 27	50·9	6–9½	Gould.
189	LL 12699 Monocerotis, . .	6	30	58	+ 6	14·1	..	Gould.
190	ν^1 Canis Majoris, . . .	6	31	8	− 18	33·7	..	W. Herschel.
191	ν^2 Canis Majoris, . . .	6	31	27	− 19	9·2	..	W. Herschel.
192	ν^3 Canis Majoris, . . .	6	32	37	− 18	8·0	..	W. Herschel.
193	LL 12788 Monocerotis, . .	6	33	27	+ 6	9·9	6–8	
194	P VI 174 Lyncis, . .	6	34	15	+ 59	33·8	Comes var.	Struve.
195	LL 12863 Monocerotis, . .	6	35	33	+ 6	27·6	6–8½ or less.	
196	33 Geminorum, . . .	6	42	56	+ 16	20·6	..	W. Herschel.
197	35 Geminorum, . . .	6	43	39	+ 13	33·3	..	W. Herschel.
198	L 2470 Canis Majoris, . .	6	45	18	− 27	11·7	6–8	Gould.
199	38 (*e*) Geminorum, . .	6	47	52	+ 13	20·1	..	Madler. Struve.
200	θ Canis Majoris, . . .	6	48	37	− 11	53·4	..	Espin. Schmidt.
201	*o*′ Canis Majoris, . . .	6	49	9	− 24	2·0	..	Gore.
202	π Canis Majoris, . . .	6	50	25	− 19	59·1	..	Gould.

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203	ε Canis Majoris,	6	53	55	− 28	49·0	..	Herschel. Schmidt.
203A	LL 13627 Monocerotis,	6	56	4	− 5	33·1	..	Gore (Feb., 1884.)
204	σ Canis Majoris,	6	56	56	− 27	45·8	3·5–4·2	Gould.
205	19 Monocerotis,	6	56	57	− 4	4·0	5·4–5·8	Gould.
206	2306 B.A.C. Monocerotis,	6	56	59	+ 11	8·8	5½–6½ (?)	Franks.
207	γ Canis Majoris,	6	58	20	− 15	27·4	..	Pigott, 1786.
208	δ Canis Majoris,	7	3	31	− 26	12·1	..	W. Herschel.
209	τ Geminorum,	7	4	31	+ 30	26·6	..	W. Herschel.
210	B 169 Lyncis,	7	8	14	+ 59	7·7	Var. colour.	Birmingham.
211	LL 14088 Canis Majoris,	7	8	19	− 22	28·2	6–9	Gore, 1877.
212	18 Heis Lyncis,	7	9	13	+ 49	39·6	5–6·3	Pierce.
213	27 Canis Majoris,	7	9	22	− 26	8·9	4½–6½	Gore.
214	LL 14123 Canis Majoris,	7	9	26	− 22	43·8	7–9	Gore, 1877.
215	γ^2 Volantis,	7	9	46	− 70	18·2	..	Gould.
216	Σ 1058 Canis Minoris,	7	10	17	+ 9	37	..	Burnham.
217	λ Geminorum,	7	11	12	+ 16	45·6	3–4	W. Herschel.
218	30 Canis Majoris,	7	13	44	− 24	44·2	..	W. Herschel.

220	ι Geminorum, . . .	7	18	17	+ 28	2·6	..	W. Herschel.
221	61 Geminorum, . . .	7	19	52	+ 20	30·0	6–7	
222	β Canis Minoris, . . .	7	20	38	+ 8	31·8	..	
223	H IV. 45 Geminorum, . .	7	22	5	+ 21	9·2	7½–10	Fletcher, 1865.
224	LL 14551 Puppis, . .	7	22	13	− 11	18·9	..	Espin, 1883.
225	65 (b^2) Geminorum, . .	7	22	21	+ 28	10·1	5–8½	?
226	W.B. 669 Monocerotis, .	7	23	15	− 1	39·5	4½–9	Olbers.
227	B 178 Monocerotis, . .	7	23	36	− 10	4·7	..	Birmingham, 1875.
228	LL 14571 Geminorum, . .	7	23	59	+ 27	52·7	..	Tebbutt, 1880.
229	— Canis Minoris, . . .	7	26		+ 11	15	6–7½	Gore.
230	δ^2 Canis Minoris, . . .	7	26	55	+ 3	32·7	..	W. Herschel.
231	9 Canis Minoris, . . .	7	27	58	+ 3	27·9	..	W. Herschel.
232	L 2858 Puppis, . . .	7	29	10	− 39	47·9	..	Gould.
233	L 2893 Puppis, . . .	7	33	21	− 31	51·5	6·7–7·5	Gould.
234	U Canis Minoris, . . .	7	35		+ 8	40	..	Baxendell, 1879.
235	LL 14970 Canis Minoris, .	7	35	17	+ 3	54·2	6·3–7·4	Gould.
236	16 Heis Argo Navis, . .	7	36		− 27	40	6–7 or less.	Gould.
237	76 (c) Geminorum, . .	7	36	48	+ 26	4·6	5·0	W. Herschel.
238	κ Geminorum, . . .	7	37	12	+ 24	41·1	Comes var.	Webb.

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239	β Geminorum, . . .	7	37	59	+ 28	18·9	Comes var. ?	Webb, 1861.
240	L 2932 Puppis, . . .	7	38	42	− 28	7·6	..	Gould.
241	π (11) Canis Minoris, . .	7	39	41	+ 11	3·8	5–6	Gore, 1876.
242	Σ 1143 Canis Minoris, . .	7	41	41	+ 5	42	..	Struve.
243	II. B. 36 Geminorum, . .	7	43	21	+ 33	32·9	6–7½	Birmingham.
244	ζ Canis Minorus, . . .	7	45	28	+ 2	4·4	5–6	
245	B 192 Camelo., . . .	7	45	54	+ 79	48·3	..	Birmingham.
246	φ Geminorum, . . .	7	46	9	+ 27	4·8	..	W. Herschel.
247	LL 15374 Monocerotis, .	7	46	53	− 5	7·1	6·0–6·6	Gould.
248	— Geminorum, . . .	7	48	16	+ 22	19	11–?	Winnecke.
249	L 3081 Puppis, . . .	7	52	53	− 30	0·7	..	Gould.
250	Anon. Argûs, . . .	7	55		− 12	13	8½	Pickering.
251	2695 B.A.C. Argûs, . .	7	57	35	− 60	11	6–0	Tebbutt, 1874.
252	8 Cancri, ...	7	58	24	+ 13	27·9	..	Gould.
253	14 Puppis, ...	7	59	21	− 19	23·8	..	W. Herschel.
254	ι (15) Argûs, . . .	8	2	26	− 23	57·6	..	Schmidt.
255	29 Monocerotis, . . .	8	2	34	− 2	38·1	Comes var.	Webb.

257	[illegible] Cancri,	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	..	Franks.
258	[illegible] 1108 Hydræ,	8	5	3	+ 1	38·1	..	Struve.
259	L 3197 Puppis,	8	7	23	− 42	37·7	5·1–5·8	Gould.
260	L 3236 Velorum,	8	10	6	− 49	49·9	5·3–7	Stone.
261	30 Monocerotis,	8	19	40	− 3	30·9	..	Franks.
262	LL 16615 Puppis,	8	21	2	− 12	8·5	..	Gould.
263	β Volantis,	8	24	25	− 65	44·2	..	Gould.
264	L 3344 Argûs,	8	24	25	− 26	56·0	6–8	Gould.
265	θ Cancri,	8	24	46	+ 18	30·3	Comes var.	Knott.
266	— Monocerotis,	8	25	13	+ 0	14·9	9–?	Dreyer, 1879.
267	L 3499 Volantis,	8	33	16	− 74	26·5	..	Gould.
268	O 515 Camelo.,	8	34		+ 83	10	..	Carrington.
269	ζ Pyxidis,	8	34	43	− 29	8·0	5½–5¾	Gould.
270	ι Cancri,	8	39	27	+ 29	12·1	..	Dembowski.
271	52 Cancri,	8	44	28	+ 16	26·9	6–8	Gore, 1878.
272	15 Hydræ,	8	45	41	− 6	43·6	5·7–6·3	Gould.
273	R Pyxidis,	8	47	57	− 36	5·6	6½–7½	Gould.
274	B 211 Cancri,	8	48	37	+ 17	41·2	6½–8½	Birmingham.
275	60 Cancri,	8	49	23	+ 12	6	6–8	Birmingham.
276	ω Velorum,	8	55	37	− 40	47·2	5–5·5	Gould.

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277	σ^2 Ursæ Majoris,	8	59	49	+ 67	37·2	Comes var.	Sadler.
278	κ Cancri,	9	1	15	+ 11	9·0	..	Gould.
279	κ Pyxidis,	9	2	47	− 25	22·5	4·9	Gould.
280	LL 18044–5 Cancri,	9	3	26	+ 31	27·3	..	d'Arrest.
281	π^1 (81) Cancri,	9	5	47	+ 15	28·6	6–7	Gore, 1877.
282	L 3731 Velorum,	9	8	43	− 38	7·2	6–7	Gould.
283	L 3744 Velorum,	9	9	44	− 43	39·0	6·2–6·8	Gould.
284	3180 BAC Argûs,	9	13	27	− 23	58	6–8	Gould.
285	26 Hydræ,	9	13	59	− 11	28·1	5–6	Franks.
286	L 3833 Pyxidis,	9	21	31	− 28	16·1	6·1–6·7	Gould.
287	α Hydræ,	9	21	41	− 8	8·4	..	Sir J. Herschel. Gemmill.
288	ξ Leonis,	9	25	29	+ 11	49·9	..	Dien.
289	3245 BAC Ursæ Majoris,	9	25		+ 72	37	..	Taylor.
290	N Velorum,	9	27	34	− 56	30·3	3·4–4·4	Gould.
291	10 Leonis,	9	30	53	+ 17	22·5	..	Gould.
292	ι (35) Hydræ,	9	33	43	− 0	35·8	..	Gould.
293	κ Hydræ,	9	34	33	− 13	47·2	..	Gore.

295	ψ Leonis,	9	37	[illegible]	+ [illegible]	[illegible]	[illegible]	[illegible]
296	16 Leonis Minoris,	9	42	52	+ 40	11·5	5 8	Franks.
297	12 Sextantis,	9	53	30	+ 3	57·5	6·1–7·0	Gould.
298	3428 BAC Hydræ,	9	56	44	− 12	43·0	6½–7½	Franks.
299	LL 19662 Sextantis,	9	57	46	− 8	59·6	4½–7	Gore, 1875.
300	♅ I 163 Sextantis,	9	59	15	− 7	8·4	Var. nebula.	Smyth.
301	υ^3 Hydræ,	9	59	17	− 12	29·0	4·5–5·2	Gould.
302	L 4174 Carinæ,	10	4	11	− 57	36·6	..	Gould.
303	LL 19814 Hydræ,	10	4	15	− 12	13·4	..	Schmidt, 1864.
304	18 Sextantis,	10	4	58	− 7	49·5	..	Secchi.
305	L 4176 Velorum,	10	5	1	− 46	51·4	6–7¾	Gould.
306	— Velorum,	10	10	2	− 43	52·3	..	Gould.
307	*q* Carinæ,	10	13	5	− 60	44·0	3·3–4·5	Gould.
308	40 Leonis,	10	13	14	+ 20	5·2	..	{ Schmidt. Franks.
309	*r* Velorum,	10	17	11	− 41	2·8	1 Mag.	Gould.
310	— Leonis,	10	17	37	+ 14	36·6	9–12	Peters.
311	γ Antliæ,	10	18	25	− 29	2·5	5–7	Gore.
312	27 Sextantis,	10	20	43	− 3	46·7	6–7	Gore.
313	α Antliæ,	10	21	40	− 30	27·4	4–5	Gould.
314	I Carinæ,	10	22	1	− 73	25·2	4·2–5·1	Gould.

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315	L 4332 Velorum, . . .	10	25	49	− 56	27·7	6½–8	Gould.
316	49 Leonis, ...	10	28	44	+ 9	16·0	..	Schmidt.
317	L 4358 Antliæ, . . .	10	29	53	− 38	56·5	5·7–6·5	Gould.
318	— Leonis, ...	10	31		+ 11	27	..	Schwab.
319	t^1 Carinæ, ...	10	31	51	− 58	56·4	5·4–6·3	Gould.
320	L 4411 Chamæleonis, . .	10	33	12	− 75	41·3	6–7	Gould.
321	LL 20592 Leonis, . .	10	33	13	+ 9	59·3	..	Hencke.
322	Star *s.p.* 40 Leo. Min., .	10	33	19	+ 26	7·0	..	Gore, 1877.
323	t^2 Carinæ, ...	10	34	11	− 58	33·5	..	Gould.
324	2543 R Ursæ Majoris, . .	10	36	44	+ 68	2	6·5	Franks.
325	L 4422 Carinæ, . . .	10	36	42	− 59	3·0	..	Thome.
326	L 4435 Carinæ, . . .	10	38	2	− 58	35·3	6·1–6·7	Gould.
327	*w* Carinæ, ...	10	38	58	− 59	56·3	4·8–5·4	Gould.
328	L 4479 Carinæ, . . .	10	43	3	− 59	14·5	6·7–7·2	Gould.
329	LL 20918 Hydræ, . .	10	45	48	− 20	36·6	7–8	Gould.
330	— Leonis, ...	10	47	18	+ 14	21·3	..	C. H. F. Peters.
331	b^3 Hydræ, ...	10	47	37	− 19	29·6	..	Gould.

333	α Ursæ Majoris, . . .	[illegible]	[illegible]	[illegible]	+ [illegible]	[illegible]	[illegible] and colour.	Klein.
334	Σ 1504 Leonis, . . .	10	57	48	+ 4	16·5	. .	Struve.
335	10 Hydræ, ...	11	2	55	− 27	25·6	. .	Gilliss.
336	L 4623 Hydræ, . . .	11	4	7	− 31	42·9	5·6–6·1	Gould.
337	H II 49 Leonis, . . .	11	9	8	+ 18	46	Var. nebula.	d'Arrest.
338	φ Leonis, ...	11	10	34	− 2	59·7	4·1–4·8	Gould.
339	L 4679 Hydræ, . . .	11	11	11	− 34	16·3	7·0–7·7	Gould.
340	Σ 1527 Leonis, . . .	11	12	43	+ 14	55·8	. .	Webb ?
341	ι Leonis, ...	11	17	40	+ 11	11·4	. .	Flammarion.
342	— Tauri, ...	11	18	8	+ 3	58·3	Var. nebula.	Tempel, 1879.
343	57 Ursæ Majoris, . . .	11	22	36	+ 39	59·8	Comes var.	Smyth.
344	LL 21860 Leonis, . .	11	23	29	+ 8	15·7	. .	Gould.
345	λ Draconis, ...	11	24	15	+ 69	59·6	. .	Gore.
346	17 Hydræ, ...	11	26	20	− 28	36	. .	
347	L 4843 Muscæ, . . .	11	33	56	− 64	43·9	. .	Gould.
348	92 Leonis, ...	11	34	32	+ 22	1·2	5–6	Franks.
349	β Leonis, ...	11	42	56	+ 15	14·6	1–2	W. Herschel. Gore, 1882.
350	β Virginis, ...	11	44	26	+ 2	26·4	. .	Webb.
351	65 Ursæ Majoris, . . .	11	48	51	+ 47	8·7	Comes var.	Smyth.
352	η Crateris, ...	11	49	54	− 16	28·9	5–6·7	Houzeau.

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353	7 (*b*) Virginis,	11	53	48	+ 4	19·4	..	Dien.
354	31 Crateris,	11	54	43	− 18	59·4	4½–6	Gore, 1875.
355	L 5013 Hydræ,	11	59	46	− 35	1·6	5·9–6·6	Gould.
356	ε Corvi,	12	3	57	− 21	57·1	..	Gould.
357	3 Corvi,	12	4	53	− 22	56·1	..	W. Herschel.
358	— Virginis,	12	7	45	+ 0	15·2	..	Harrington, 1881.
359	δ Ursæ Majoris,	12	9	29	+ 57	42·0	..	Schmidt.
360	γ Corvi,	12	9	38	− 16	52·5	..	Gould.
361	ε Muscæ,	12	11	6	− 67	17·6	4·3–5·3	Gould.
362	η Virginis,	12	13	46	0	0	..	Gould.
363	ε Crucis,	12	14	54	− 59	44·3	4–6	
364	4166 BAC Ursæ Minoris,	12	15	48	+ 84	2	6–8	Tennant.
365	LL 23228–9 Virginis,	12	19	0	− 10	56·6	5½–8	
366	L 5142 Centauri,	12	19	3	− 34	31·3	5·6–6·2	Gould.
367	B 277 Virginis,	12	19	7	+ 1	26·9	6–8	Birmingham.
368	4193 BAC Ursæ Minoris,	12	20	6	+ 84	6	6–8·5	Tennant.
369	δ Corvi,	12	23	40	− 15	50·8	..	Gould.

371	B 281 Virginis, ...	12	24	14	+ 5	4·6	8½–9½	Birmingham.
372	γ Crucis, ...	12	24	31	− 56	26·4	..	Gould.
373	η Corvi, ...	12	25	56	− 15	31·8	..	W. Herschel.
374	β Canes Venatici, . . .	12	28	5	+ 42	0·4	..	Smyth.
375	β Corvi, ...	12	28	5	− 22	44·0	One mag.	{ Smyth. Sawyer. Gould.
376	24 Comæ, ...	12	29	6	+ 19	2·2	..	Gould.
377	DM 17°, 2510 Comæ, . .	12	32	57	+ 17	9·9	8·8–10	Weiss.
378	9 Canes Venatici, . .	12	33	1	+ 41	31·9	5·8–6·9	Peirce.
379	DM 17°, 2511 Comæ, . .	12	33	9	+ 17	8·8	One mag.	Weiss.
380	LL 23676 Corvi, . . .	12	34	33	− 12	21·5	5–7½	
381	γ Virginis, ...	12	35	35	− 0	47·5	..	Struve.
382	LL 23726 Corvi, . . .	12	37	18	− 13	12·1	5–8	
383	B 290 Canes Venatici, . .	12	39	29	+ 46	5·7	4·5–6·5	Schmidt.
384	LL 23824 Virginis, . .	12	40	56	+ 6	36·5	..	Gould.
385	L 5300 Centauri, . . .	12	45	20	− 39	1·6	..	Gould.
386	Σ 1686 Comæ, ...	12	46	59	+ 15	40·8	..	Struve?
387	ε Ursæ Majoris, . . .	12	48	44	+ 56	36·7	..	Sir J. Herschel.
388	— Draconis, ...	12	52		+ 66	39	..	Burnham.
389	L 5344 Centauri, . . .	12	52	4	− 35	37·5	6·3–7·0	Gould.
390	ε Virginis, ...	12	56	13	+ 11	36·2	..	Smyth.

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391	— Virginis, ...	12	58		− 10	31	. .	Pigott, 1786.
392	L 5397 Centauri, . . .	12	59	47	− 40	56·7	. .	Gould.
393	ψ Hydræ, ...	13	2	35	− 22	28·5	. .	Franks.
394	50 Virginis, ...	13	3	29	− 9	41·3	. .	Gould.
395	L 5412 Centauri, . . .	13	3	40	− 52	16·1	6¾–7¼	Thome.
396	— Virginis, ...	13	8		− 15	56	6?–9	Olbers, 1797.
397	L 5460 Centauri, . . .	13	9	31	− 44	4·7	7–7½	Gould.
398	γ Hydræ, ...	13	12	22	− 22	32·2	. .	
399	Σ 1734 Virginis, . . .	13	14	36	+ 3	34·4	Comes var.	Secchi.
400	63 Virginis, ...	13	16	36	− 17	6·4	5·2–5·9	Gould.
401	68 (i) Virginis, . . .	13	20	23	− 12	4·9	5½–8	Secchi.
402	69 Virginis, ...	13	21	3	− 15	21·0	4·8–5·4	Gould.
403	72 Virginis, ...	13	24	11	− 5	49·0	6·7	Gould.
404	— Virginis, ...	13	24		− 9	4	. .	Hind.
405	76 Virginis, ...	13	26	39	− 9	32·8	5–6	{ Espin. { Gore.
406	L 5590 Centauri, . . .	13	27	55	− 32	41·7	6·5–7·2	Gould.
407	ζ Virginis, ...	13	28	35	+ 0	1·1	. .	{ W. Herschel. { Gore.

409	65 Hora Canes Venatici,	13	30	9	+ 11	48·6	5·8–6·0	Peirce.
410	LL 25224 Virginis,	13	33	40	+ 11	21·3	..	Gould.
411	— Virginis,	13	34		− 0	59	6–0	Pigott, 1785.
412	83 Ursæ Majoris,	13	36	11	+ 55	17·4	3·7–5·3	Birmingham, 1868.
413	τ Bootis,	13	41	34	+ 18	3·3	Comes var.	Webb.
414	ν Centauri,	13	42	19	− 41	5·3	3·3–3·7	Gould.
415	η Ursæ Majoris,	13	42	49	+ 49	54·7	..	{ Lalande. { Espin.
416	2 (*g*) Centauri,	13	42	30	− 33	51·0	4·5–5·1	Gould.
417	υ Bootis,	13	43	42	+ 16	23·6	..	Schmidt.
418	4632 BAC Canes Venatici,	13	46	30	+ 35	2·9	..	Franks.
418A	W. B. XIII, 830 Virginis,	13	52	4	− 3	4	..	Gould.
419	θ Apodis,	13	53	41	− 76	13·0	5·6–6·6	Gould.
420	— Virginis,	13	55		− 20	14	..	Knorre.
421	— Virginis,	13	58	31	− 8	37·4	..	Peters.
422	θ Centauri,	13	59	37	− 35	46·7	..	Gould.
423	α Draconis,	14	1	8	+ 64	57·0	..	{ W. Herschel. { Pigott.
424	— Virginis,	14	3	52	− 12	44·2	..	Palisa.
425	LL 26031 Virginis,	14	6	11	+ 2	58·6	4·8–5·5	Gould.
426	15 Bootis,	14	8	59	+ 10	40·1	..	W. Herschel.
427	α Bootis,	14	10	11	+ 19	48·5	..	

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428	WB 143 Virginis, . . .	14	10	17	− 2	38·2	..	Gould.
429	L 5891 Lupi, . . .	14	13	3	− 44	37·9	..	Houzeau, 1875.
430	LL 26211 Bootis, . . .	14	13	5	+ 40	27·9	6–9	Gore, 1877.
431	υ Virginis, ...	14	13	21	− 1	42·6	5·0–5·6	Gould.
432	LL 26200 Virginis, . .	14	13	33	+ 0	56·3	5·9–6·6	Gould.
433	103 Virginis, . . .	14	15	47	− 1	26·3	..	Gould.
434	51 (*k*) Hydræ, . . .	14	16	11	− 27	12·1	5·0–6	Gould.
435	— Virginis, ...	14	16	14	+ 0	6·6	Var. neb. ?	Barnard, 1882.
436	B 327 Bootis, . . .	14	18	24	+ 8	38	6–7½	Birmingham.
437	B 328 Bootis, . . .	14	18	47	+ 26	15·0	7·3–9	Birmingham.
438	θ Bootis, ...	14	21	8	+ 52	24	..	Peirce.
439	*l* (52) Hydræ, . . .	14	21	9	− 28	57·1	4·8–6	Gould.
440	φ Virginis, ...	14	22	1	− 1	41·4	4·8–5·4	Gould.
441	B 334 Bootis, . . .	14	29	44	+ 37	9·2	6–7	Birmingham.
442	— Libræ, ...	14	34		− 20	48	..	Peters.
443	π Bootis, ...	14	35	5	+ 16	55·9	..	Schmidt.
444	ζ Bootis, ...	14	35	24	+ 14	14·6	..	Struve. Secchi.

446	31 Bootis, . . .	14	35	45	+ 6	40·6	..	Gould.
447	34 Bootis, ...	14	38	9	+ 27	2·4	..	Schmidt.
448	ε Bootis, ...	14	39	44	+ 27	35	..	{ Baxendoll. { Gemmill.
449	L 6082 Centauri, . . .	14	40	21	− 56	9·6	6–7	Gould.
450	LL 26980 Bootis, . . .	14	42	56	+ 6	27·6	..	Gould.
451	LL 27017 Bootis, . . .	14	43	49	+ 8	29·1	6–7	Gould.
452	L 6077 Apodis, . . .	14	44	16	− 76	10·3	5·5–6·2	Gould.
453	LL 27095 Bootis, . . .	14	46	6	+ 37	52·3	7–0	Bode, 1804.
454	L 6137 Centauri, . . .	14	47	18	− 32	48·6	..	Gould.
455	β Ursæ Minoris, . . .	14	51	4	+ 74	38·7	..	{ J. Herschel, Struve, { Espin.
456	LL 27307 Bootis, . . .	14	53	33	+ 25	31·7	7–9½	
457	L 6198 Lupi, . . .	14	55	38	− 32	10·3	..	Gould.
458	20 Libræ, ...	14	57	2	− 24	48·5	3·4–5	Franks.
458A	44 Bootis, ...	14	59	52	+ 48	7·2	..	Argelander and Struve.
459	47 (*k*) Bootis, . . .	15	1	27	+ 48	38·4	5–6	Peirce.
460	δ Bootis, ...	15	10	39	+ 33	45·8	..	{ Chandler. { Heis.
461	Σ 1932 Coronæ, . . .	15	13	11	+ 27	16·4	..	Struve.
462	L 6320 Lupi, . . .	15	13	25	− 44	30·2	..	{ Taylor. { Gould.
463	δ Lupi, ...	15	13	30	− 40	12·7	3·4–3·7	Gould.
464	L 6308 Triang. Aust., . .	15	14	56	− 67	53	6·4–6·8	Gould.

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465	— Triang. Aust.	15	16	38	− 66	41·8	7·0–7·8	Gould.
466	ε Libræ, ...	15	17	42	− 9	53·3	..	Gore.
467	L 6417 Lupi, . . .	15	27	19	− 49	6·3	7–9½	Gould.
468	L 6439 Lupi, . . .	15	28	40	− 32	41·4	6·4–6·9	Gould.
469	γ Libræ, ...	15	28	48	− 14	28·4	3–6	
470	δ Serpentis, ...	15	29	4	+ 10	56·3	..	Webb ?
471	α Coronæ Borealis, . .	15	29	36	+ 27	7·2	..	Baxendell.
472	μ Coronæ Borealis, . .	15	30	50	+ 39	24·5	..	Franks.
473	τ⁴ Serpentis, . . .	15	30	54	+ 15	30	6–0	Birmingham.
474	Σ 1964 Coronæ Borealis, .	15	33	41	+ 36	38·4	..	Webb.
475	LL 28590 Libræ, . . .	15	35	52	− 10	45·4	..	Struve. Weiss, 1879.
476	LL 28607 Libræ, . . .	15	36	44	− 10	32·1	7–8·8	Weiss, 1879.
477	α Serpentis, ...	15	38	22	+ 6	48·2	Comes var.	Webb ?
478	L 6514 Lupi, . . .	15	39	5	− 34	18·3	5½–6½	Gould.
479	LL 28716 Serpentis, . .	15	39	27	+ 5	49·5	4·8–6·1	Gore.
479A	— Libræ, ...	15	39	22	− 20	45·3	..	Peters.
480	Anon. Coronæ Borealis, .	15	43	35	+ 28	38·1	11–13	Schmidt.
481	5246 B.A.C. Draconis,	15	44	48	+ 55	44·5	5–7	Butillon.

482	L 6646 Normæ, . . .	15	45	[illegible]	– [illegible]	49·1	6·0–6·5	Gould.
483	ρ Serpentis, ...	15	46	59	+ 21	20·4	..	Franks.
484	L 6536 Apodis, . . .	15	47	30	– 72	6·9	6·7–7·4	Gould.
485	39 Serpentis, . .	15	47	38	+ 13	35·1	..	
486	ζ Ursæ Minoris, . . .	15	48	22	+ 78	10	4·2–4·7	Espin.
487	L 6578 Triang. Aust. . .	15	50	25	– 63	26	6·8–7·5	Gould.
488	DM 26°, 2760 Coronæ, . .	15	53	10	+ 26	35·6	8·9–9·1	Gould.
489	β Scorpii, ...	15	58	28	– 19	28·5	..	Kirch. Powell.
490	67 Heis Draconis, . .	15	58	42	+ 55	52	6·3–8½	Gore.
491	5341 BAC Draconis, . .	15	59	1	+ 53	15·0	..	Franks.
492	LL 29344 Scorpii, . .	16	1	33	– 23	21·9	..	Gore.
493	κ Herculis, ...	16	2	39	+ 17	21·9	..	W. Herschel.
494	B 872 Serpentis, . . .	16	3	35	+ 1	8·4	6–7½	Birmingham.
495	— Scorpii, ...	16	4	46	– 19	49·4	..	Palisa. Peters.
496	12 Scorpii, . . .	16	4	51	– 28	6·3	6–7	Gould.
497	— Herculis, ...	16	5		+ 19	40	..	Schmidt.
498	WB 140 Scorpii, . . .	16	9	5	– 14	32·8	One mag.	Gould.
498A	σ Coronæ Borealis, . .	16	10	12	+ 34	10	Comes var. ?	
499	L 6783 Normæ, . . .	16	12	38	– 47	53·9	6·9–7·3	Gould.
500	LL 29822 Ophiucii, . .	16	16	55	– 0	34·6	6·3–7·3	Gould.

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501	χ Ophiucii, ...	16	20	4	− 18	10·9	4·3–4·7	Gould.
502	B 379 Ophiucii, . . .	16	20	4	− 12	8·7	7·5–9	Birmingham.
503	α Scorpii, ...	16	22	3	− 26	9·9	Var. col. and mag.	Secchi. Baxendell.
504	η Draconis, ...	16	22	22	+ 61	47	Comes var.	Rogers.
505	β Herculis, ...	16	25	4	+ 21	45·1	. .	W. Herschel.
506	29 Herculis, ...	16	27	0	+ 11	44·7	. .	W. Herschel.
507	H Scorpii, ...	16	28	28	− 35	0·4	4¼–5·0	Gould.
508	33 Herculis, ...	16	31	2	+ 7	21·0	6–8	W. Herschel.
509	17 Draconis, ...	16	33	23	+ 53	9·9	. .	Struve.
510	B 391 Ophiucii, . . .	16	45	1	− 5	58·2	8½–11	Birmingham.
511	ι Ophiucii, ...	16	48	20	+ 10	21·8	. .	Gould.
512	— Scorpii, ...	16	48	57	− 32	57·5	6½–8½	Gould.
513	24 Ophiucii, ...	16	49	34	− 22	57·5	5½–6½	Franks.
514	L 7057 Aræ, ...	16	51	6	− 56	22·3	6·5–7.3	Gould.
515	30 Ophiucii, ...	16	54	42	− 4	2·5	5·1–5·9	Gould.
516	20 Draconis, ...	16	55	49	+ 65	13·3	. .	Smyth.
517	5749 BAC Herculis, . .	16	57	38	+ 14	16·0	5–6·7	Franks.

520	β V 282 Ophiucii, . .	17	8	29	− 14	27	5–7	Burnham.
521	ι Apodis, ...	17	8	43	− 69	59·7	5·1–6·0	Gould.
522	69 (*e*) Herculis, . . .	17	13	31	+ 87	24·9	5–6	H. T. Vivian, 1870.
523	L 7267 Aræ, . . .	17	18	1	− 45	44·0	..	Gould.
524	44 (*b*) Ophiucii, . . .	17	19	2	− 24	3·8	3·6–6·2	
525	LL 31727 Ophiucii, . .	17	20	16	− 4	58·7	..	Gould.
526	σ Ophiucii, ...	17	20	34	+ 14	14·7	4–5	Gould.
527	51 (*c*) Ophiucii, . . .	17	24	5	− 23	52·1	4·8–5·6	Gould.
528	— Aræ, ...	17	30	30	− 45	23·1	5–11	Tebbutt, 1877.
529	B 418 Serpentis, . . .	17	37	53	− 18	36·1	7½–0	Birmingham.
530	— Sagittarii, . . .	17	41		− 31	33	7–?	Gore.
531	88 (*z*) Herculis, . . .	17	46	57	+ 48	25	5½–7	Peirce.
532	B 420 Ophiucii, . . .	17	48	8	+ 1	47·5	7·5–0	Birmingham.
533	LL 32847 Sagitt., . .	17	51	41	− 22	30·5	..	
534	B 422 Ophiucii, . . .	17	52	2	+ 2	44·1	7–8·5	Birmingham.
535	65 Ophiucii, ...	17	53	23	− 17	59·7	..	Baily.
536	DM 45°, 2627 Herculis, .	17	53	25	+ 45	22·7	..	Peirce.
537	68 Ophiucii, ...	17	55	40	+ 1	18·5	4·4–5·1	Gould.
538	π Pavonis, ...	17	57	8	− 63	40·2	..	Stone.

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539	γ Sagittarii, ...	17	58	6	− 30	25·5	..	Gould.
540	LL 33212 Herculis, . .	17	59	56	+ 25	3·4	7–?	Gore, 1878.
541	O A 17670 Sagittarii, . .	18	0	51	− 17	10·1	4½–7	Gould.
542	72 Ophiucii, . . .	18	1	40	+ 9	32·9	Comes var.	Struve.
543	B 427 Sagittarii, . . .	18	2	50	− 15	8·1	8–0	Birmingham.
544	L 7646 Scorpii, . . .	18	9	39	− 34	8·8	..	Gould.
545	Y 7736 Sagittarii, . .	18	10	11	− 17	24·8	..	Gould.
546	L 7681 Sagittarii, . .	18	14	8	− 24	58·0	6–7½	Gould.
547	L 7686 Sagittarii, . . .	18	14	46	− 22	58·5	6½–8	Gould.
548	η Serpentis, ...	18	15	6	− 2	55·6	..	
549	φ Draconis, ...	18	22	30	+ 71	16·5	..	Gemmill.
550	κ Coronæ Aust., . . .	18	25	7	− 38	48·6	..	
551	42 Draconis, . . .	18	25	37	+ 65	29·4	5–6	Franks.
552	B 447 Aquilæ, . . .	18	26	44	− 5	14·9	Var. colour.	Birmingham.
553	B 448 Lyræ, . . .	18	28	9	+ 36	54·1	8–9	Birmingham.
554	α Scuti, ...	18	28	40	− 8	19·6	3·5–5·2	Gould.
555	O Σ 358 Herculis, . .	18	31		+ 16	53	..	Webb?

558	ε Lyræ, ...	18	40		+ 39	53	..	Struve and Grover.
559	29 Sagittarii, . . .	18	42	33	− 20	27·6	5·4–6·3	Gould.
560	B 464 Aquilæ, . . .	18	43	18	− 8	2·5	7–9½	Birmingham.
561	LL 35150 Serpentis, . .	18	46	32	+ 13	49·4	..	Gould.
562	σ Sagittarii, ...	18	47	49	− 26	26·6	..	W. Herschel.
563	θ Serpentis, ...	18	50	15	+ 4	2·8	..	Gould. Smyth.
564	11 Aquilæ, ...	18	53	34	+ 13	27·9	..	Gould.
565	ε Aquilæ, ...	18	54	10	+ 14	54·3	..	W. Herschel.
566	12 Aquilæ, ...	18	55	16	− 5	54·6	3·8–5	Goujon, 1848. Gould.
567	λ Lyræ, ...	18	55	29	+ 31	58·6	4½–6	Birmingham.
568	B 483 Aquilæ, . . .	18	58	0	− 5	51·7	7½–?	Knott. Schmidt.
569	Y 8122 Sagittarii, . .	19	0	7	− 18	55·3	6–7	Gould.
570	18 Aquilæ, ...	19	1	20	+ 10	53·2	5–6	Gould.
571	π Sagittarii, ...	19	2	38	− 21	12·8	..	Gould.
572	B 487 Vulpeculæ, . .	19	3	37	+ 23	59·4	6–7·5	Birmingham.
573	P XIX 13 Lyræ, . . .	19	4	24	+ 37	43·2	Comes var.	Webb.
574	LL 36099 Aquilæ, . .	19	7	50	+ 5	18·8	6–6·7	Gould.
575	53 Draconis, . . .	19	9	24	+ 56	39	5–6	Gore.
576	43 (*d*) Sagittarii, . . .	19	10	37	− 19	9·8	4–6	Gore.

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577	24 Aquilæ, ...	19	12	42	+ 0	7·3	..	W. Herschel.
578	B 492 Cygni, . . .	19	14	25	+ 27	2·1	7–9	Birmingham.
579	6624 BAC Cygni, . . .	19	14	57	+ 40	8·4	..	Franks.
580	χ^3 Sagittarii, . . .	19	18	14	− 24	11·8	5·6–6·2	Gould.
581	31 (*b*) Aquilæ, . . .	19	19	14	+ 11	40·2	..	Gore.
582	LL 36606 Sagittarii, . .	19	19	21	− 21	29·1	6·5–9·0	?
583	B 498 Aquilæ, . . .	19	21	47	+ 1	56·0	7·8–8·5	Birmingham.
584	LL 36781 Aquilæ, . .	19	22	3	+ 14	2·5	6–7	Gould.
585	α Vulpeculæ, . . .	19	23	43	+ 24	25·4	..	Franks.
586	LL 36863 Aquilæ, . .	19	24	9	+ 2	39·4	6·3–7·2	Gould.
587	36 (*e*) Aquilæ, . . .	19	24	24	− 3	2·2	5–7·5	
588	B 502 Draconis, . . .	19	25	50	+ 76	19·9	6–9	Birmingham.
589	β Cygni, ...	19	25	53	+ 27	42·5	..	{ Klein. Webb.
590	DM 17°, 3997 Sagittæ, . .	19	27	16	+ 17	27·9	6–9·4	?
591	μ Aquilæ, ...	19	28	14	+ 7	7·6	4·4–5·3	Gould.
592	ι Aquilæ, ...	19	30	31	− 1	33·6	..	Gould.
[illegible]	[illegible]	19	[illegible]	[illegible]	[illegible]	[illegible]	Comes var.	Webb.

596	χ Aquilæ, ...	19	36	55	+ 11	32·6	..	Gould.
597	B 510 Aquilæ, . . .	19	38	14	+ 4	40·6	7·0–9	Birmingham.
598	DM 41°, 3469 Cygni, . .	19	39	45	+ 41	29·5	5·6–?	Peirce.
599	LL 37621 Cygni, . . .	19	40	8	+ 34	7·4	6–7	Köhl, 1878.
600	P XIX 276 Cygni, . .	19	41	15	+ 35	28·0	..	Dembowski.
601	B 514 Cygni, . . .	19	42	38	+ 44	49·5	10–0	Birmingham.
602	π Aquilæ, ...	19	43	3	+ 11	31·1	..	Gould.
603	ε Pavonis, ...	19	46	41	– 73	13·5	3·6–4·2	Gould.
604	LL 37868 Vulpeculæ, . .	19	46	59	+ 24	41·0	5–7	Schmidt.
605	9 Sagittæ, ...	19	47	0	+ 18	21·7	..	W. Herschel.
606	ε Draconis, ...	19	48	34	+ 69	58	..	Webb. Johnson.
607	β Aquilæ, ...	19	49	25	+ 6	6·5	..	
608	10 Sagittæ, ...	19	50	34	+ 16	19·0	..	
609	η Cygni, ...	19	51	48	+ 34	45·8	..	J. Herschel, 1842.
610	62 (c) Sagittarii, . . .	19	55	16	– 28	2·3	..	Gould.
611	LL 38405 Aquilæ, . .	20	0	17	– 4	45·7	6½–8	?
612	27 (b^1) Cygni, . . .	20	1	56	+ 35	38·0	..	W. Herschel.
613	LL 38506 Aquilæ, . .	20	2	3	+ 9	3·1	6–6·6	Gould.
614	66 Aquilæ, ...	20	7	2	– 1	22·0	5½–6½	Gore.

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615	L 8381 Sagittarii, . . .	20 7 48	− 27 23·4	4½–6·3	Gould.
616	L 8385 Sagittarii, . . .	20 8 34	− 36 49·1	0·6 mag.	Gould.
617	Near Carrington 3082, .	20 9	+ 88 40	9–10–11·2	Gore.
618	Carrington, 3106 Ư Min., .	20 10	+ 88 32	7·5–9·4	Johnson.
619	V Capricorni, . . .	20 10 5	− 21 41·1	6½–8½	{ Secchi. { Gore.
620	7001 BAC Cygni, . . .	20 14 35	+ 28 36·8	..	Franks.
621	α Pavonis, ...	20 16 9	− 57 7·1	2·–2·6	J. Herschel.
622	LL 39222 Aquilæ, . .	20 18 30	+ 0 40·9	..	
623	B 558 Delphini, . . .	20 19 58	+ 9 40·1	6–0	{ Birmingham. { Gould.
624	π Capricorni, . . .	20 20 27	− 18 36·3	4·3–5·5	{ Lynn Gore.
625	— Capricorni, . . .	20 23 51	− 12 37·9	6½–8½	Gould.
626	ρ Pavonis, ...	20 27 31	− 61 56·5	..	Gould.
627	θ Cephei, ...	20 27 34	+ 62 35	..	W. Herschel.
628	ω³ Cygni, ...	20 27 37	+ 48 49·6	..	Franks.
629	η Delphini, ...	20 28 16	+ 12 38·0	..	Franks.
630	47 Cygni, ...	20 29 13	+ 31 50·4	..	W. Herschel.
631	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

633	[illegible] Delphini,	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	..	Franks.
634	71 Aquilæ,	20	32	8	− 1	31·4	4·2–4·6	Gould.
635	Near α Cygni,	20	37	25	+ 47	42·8	8½–12 (?)	Birmingham. Baxendell.
636	B 569 Delphini,	20	39	58	+ 17	39·4	6·3–8	d'Arrest. Espin.
637	118 Heis Cygni,	20	40	38	+ 46	51·7	6–7	Peirce.
638	13 Delphini,	20	41	52	+ 5	34·1	..	Schmidt.
639	7219 BAC Cygni,	20	43	13	+ 45	8	..	Franks.
640	14 Delphini,	20	43	56	+ 7	25·1	..	Schmidt. Gould.
641	123 Heis Cygni,	20	43	57	+ 47	23·5	..	Peirce.
642	55 Cygni,	20	44	45	+ 45	40·4	5½–6½	W. Herschel.
643	4 Aquarii,	20	44	58	− 6	4·7	..	Peirce.
644	5 Aquarii,	20	45	49	− 5	57.6	5·1–5·8	Gould.
645	32 Vulpeculæ,	20	49	26	+ 27	36	..	Gilliss. Franks.
646	7 Aquarii,	20	50	25	− 10	9·5	..	Gould. Gore.
647	B 573 Delphini,	20	51	36	+ 15	47·5	6·5–0	Birmingham.
648	37 Heis Capricorni,	21	1	0	− 17	56·3	..	Heis.
649	27 Capricorni,	21	2	41	− 21	2·0	6·3–6·8	Gould.
650	6 Equulei,	21	4	42	+ 9	33·6	5–7	W. Herschel.
651	P XXI 21 Equulei,	21	6	42	+ 2	9·1	6–9	
652	L 8721 Pavonis,	21	8	3	− 65	10·8	½ a mag.	Gould.

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653	29 Capricorni, . . .	21	9	7	− 15	40·2	..	Franks. Gore.
654	B 579 Cephei, . . .	21	9	46	+ 59	37·2	6·5–9	Birmingham.
655	L 8768 Indi, . . .	21	13	2	− 50	26·4	6·1–7·3	Gould.
656	P XXI 87 Capricorni, . .	21	16	8	− 23	10·8	6–7	Franks, 1877.
657	γ Pavonis, ...	21	16	31	− 65	54·6	3–4·5	J. Herschel.
658	1 Pegasi, ...	21	16	31	+ 19	17·3	..	Smyth.
659	33 Capricorni, . . .	21	17	21	− 21	21·6	5½–7½	Chacornac.
660	18 Aquarii, ...	21	17	38	− 13	23·6	..	W. Herschel.
661	γ Indi, ...	21	17	41	− 55	10·7	6·0–6·6	Gould.
662	B 584 Cygni, . . .	21	26	24	+ 51	3·3	9–11	Secchi.
663	β Cephei, ...	21	27	6	+ 70	2·0	..	Schmidt.
664	7489 BAC Cygni, . .	21	27	25	+ 52	5·4	6–7	Franks.
664A	B 587 Cygni, . . .	21	31	30	+ 44	50·4	5½–7½	Peirce. Gore.
665	41 Capricorni, . . .	21	35	10	− 23	48·3	..	Franks.
666	ε Pegasi, ...	21	38	18	+ 9	19·5	..	Schwab. Gould.
667	46 Capricorni, . . .	21	38	36	− 9	40·6	..	Franks.
668	κ Pegasi, ...	21	39	12	+ 26	5·6	Comes var.	Dembowski.

670	28 Aquarii, ...	21	54	50	+ 0	1·7	..	W. Herschel.
671	LL 42958 Pegasi, . . .	21	56	8	− 10	23·8	6·1–6·6	Gould.
672	— Aquarii, ...	21	56	17	− 17	12·3	..	Peters.
673	30 Aquarii, ...	21	56	58	− 7	6·1	5·3–6·0	Gore, 1874.
674	B 600 Pegasi, . . .	21	58	32	+ 27	46·2	6½–8	Birmingham.
675	32 Aquarii, ...	21	58	37	− 1	29·2	..	W. Herschel.
676	υ Piscis Australis, . . .	22	1	25	− 34	37·6	..	Gould.
677	2 Heis Lacertæ, . . .	22	1		+ 44	26	4·6–7	Peirce.
678	L 9036 Piscis Australis, .	22	2	55	− 34	36·3	..	Gould.
679	36 Aquarii, ...	22	3	6	− 8	46·6	6½–7·2	Gould.
680	θ Pegasi, ...	22	4	8	+ 5	36·5	3·2–3·8	Gould.
681	LL 43239 Aquarii, . .	22	4	18	− 4	51·3	6–7	
682	39 Aquarii, ...	22	5	57	− 14	47·0	6·1–6·6	Gould.
683	B 607 Lacertæ, . . .	22	8	43	+ 39	7·1	4½–7½ ?	Secchi.
684	γ Aquarii, ...	22	15	27	− 1	59·5	3–4	W. Herschel.
685	610 B Cephei, . . .	22	18	37	+ 55	21·4	..	Secchi.
686	Anon. Aquarii, . . .	22	23	4	− 10	32·7	7·8–0	Rumker.
687	ζ Piscis Australis, . . .	22	24	13	− 26	41·2	..	Schmidt.
688	67 Aquarii, ...	22	36	59	− 7	35·4	..	
689	66 Aquarii, ...	22	37	8	− 19	27·4	..	{ Franks. Gould.

No.	Star.	R.A., 1880.	Declination, 1880.	Supposed Change of Magnitude.	Authority.
		H. M. S.	° ′		
690	η Pegasi, ...	22 37 23	+ 29 35·6	..	Christie.
691	ξ Pegasi, ...	22 40 41	+ 11 33	4·3–4·8	Gould.
692	ϵ Gruis, ...	22 41 18	− 51 56·8	..	Gould.
693	69 Aquarii, ...	22 41 20	− 14 41·6	..	W. Herschel.
694	— Aquarii, ...	22 42	− 12 27	Var. nebula.	Tempel, 1879.
695	ι Cephei, ...	22 45 25	+ 65 34	..	Schmidt, 1857.
696	γ (22) Piscis Australis, .	22 45 41	− 33 30·7	4·5–6·0	Gould.
697	LL 44782 Piscium, . .	22 47 38	+ 1 12·4	6½–8	Gould.
698	ρ Pegasi, ...	22 49 11	+ 8 10·5	..	Gore.
699	45 Heis Lacertæ, . . .	22 51 12	+ 4 96	4·5–5·8	Peirce.
700	51 Pegasi, ...	22 51 34	+ 20 7·5	..	W. Herschel.
701	B 625 Aquarii, . . .	22 52 35	− 25 48·2	Var. spectrum.	Secchi.
702	α Pegasi, ...	22 58 47	+ 14 33·6	..	Christie. ?
703	55 Pegasi, ...	23 0 57	+ 8 45·6	5–5·5	{ Birmingham. { Secchi.
704	56 Pegasi, ...	23 1 15	+ 24 49·3	..	Franks.
705	57 Pegasi, ...	23 3 29	+ 8 1·6	..	Gore.
706	59 Pegasi, ...	23 5 41	+ 8 4·1	..	Gore.

708	303 Bode Aquarii, . .	23	11	24	− 12	22·1	..	Schmidt.
709	22743 A.O. Aquarii, . .	23	12	9	− 19	29·9	..	Schulhof.
710	8 Andromedæ, . . .	23	12	11	+ 48	22	..	Gore, 1876.
711	ψ^3 Aquarii, ...	23	12	42	− 10	16·0	..	Schmidt.
712	8122 BAC Cephei, . .	23	13	13	+ 73	2·2	6–10	{ Liouville, 1856. Franks, 1877.
713	B 637 Pegasi, . . .	23	14	15	+ 22	26·1	5·0–0	Birmingham.
714	— Cephei, ...	23	15	11	+ 55	27·4	..	Argelander, 1863.
715	L 9455 Gruis, . . .	23	17	6	− 54	28·0	..	Gould.
716	LL 45980 Aquarii, . .	23	23	18	− 5	11·0	6·3–7¼	Gould.
717	100 Aquarii, . . .	23	25	25	− 22	1·9	..	W. Herschel.
718	LL 46090 Aquarii, . .	23	26	12	− 11	39·7	6–7	Schmidt, 1878.
719	ι Phœnicis, ...	23	28	37	− 43	16·6	4·4–5·1	Gould.
720	L 9535 Phœnicis, . . .	23	31	23	− 46	9·3	..	Gould.
721	ι Andromedæ, . . .	23	32	15	+ 42	36·2	4–7	
722	γ Cephei, ...	23	34	26	+ 76	57·7	..	Gemmill.
723	104 Aquarii, ...	23	35	33	− 18	29	4–5	W. Herschel.
724	LL 46442 Piscium, . .	23	35	50	+ 6	34·8	6–7	Gould.
725	8245 BAC Andromedæ, .	23	36	20	+ 44	20·6	..	Franks.
726	ω^2 Aquarii, ...	23	36	29	− 15	12·4	..	W. Herschel.
727	LL 46504 Pegasi, . . .	23	37	56	+ 28	41·9	..	

No.	Star.	R.A., 1880. h. m. s.	Declination, 1880. ° ′	Supposed Change of Magnitude.	Authority.
728	107 Aquarii, ...	23 39 47	− 19 20	Var. col.	Piazzi Smyth.
729	19 Piscium, . . .	23 40 15	+ 2 49·2	4·8–6·5	{ Gould. Espin.
730	80 Pegasi, ...	23 45 14	+ 8 39·0	5½–6½	Gould.
731	82 Pegasi, ...	23 46 30	+ 10 16	5·3–6	Gould.
732	B 651 Cephei, . . .	23 46 32	+ 74 51·7	Var. colour.	Birmingham.
733	P XXIII 216,217 Pegasi, .	23 46 51	+ 11 15·7	..	{ Struve. Webb.
734	L 9643 Sculptoris, . .	23 49 4	− 32 35·3	5·5–6·7	Gould.
735	LL 47032–4 Andromedæ, .	23 53 22	+ 33 3·7	5·6–7·8	Labaume.
736	3 Ceti, ...	23 58 21	− 11 10·5	4·9–5·9	Gould.

NOTES AND OBSERVATIONS.

No. 1. γ PEGASI.—Schwab finds for this star a period of about 27½ days. He found it equal in brightness to α Pegasi at maximum, and to η Pegasi at mimimum; but these comparison stars have also been suspected of variation (*Observatory*, April, 1879, p. 420). Sir J. Herschel rated it 3·11 (*Cape. Obs.*, p. 440); and Franks, 2½ m., November 16, 1877; Pritchard, 2·47 (1882·661). From observations at Cordoba, Dr. Gould also finds evidence of variation. On August 19, 1871, it was found brighter than η Ophincii, or about 2·5, and on September 5, midway between α and δ Aquarii, or about 3·1. 3·04 HP.

No. 2. Star near γ PEGASI.—Not in *Lalande's Catalogue*. 7 m. Harding. Observed by Olbers, September 27, 1820, as 6–7 m., somewhat brighter than 39, and nearly equal to 40 Piscium (*Nature*, August 15, 1878). It is 7·5 in the *Durchmusterung*. It was not observed by Bessel, but he has recorded a star of 9 m. *p* Argelander's position of Olbers' star 7^s·0 and 3′58″ *n* of it, where the DM has no star.

October 21, 1878.—I found it brighter than 39, and nearly equal to 40 Piscium; September 10, 1883, brighter than 39, but 3 steps less than 40.

No. 3.—PISCIUM.—Position given in the Catalogue is only approximate.

No. 4. LALANDE, 405–6 CETI.—6 m. Lalande. Not in *Heis' Catalogue*, 6·5 Gould. Considered by Chandler (Jun.) to be variable from 5·2 to 6·4. The variability was confirmed by Sawyer.

No. 5.—CETI.—Included by Schönfeld in his provisional list. He says, "1871, November 3, 6·7^m.; November 8, 8^m.; November 24, 10^m. und nicht weiter veränderlich; auch in meinen Beobachtungen nicht oder kaum. Ich halte die Richtigkeit dieser Wahrnehmungen für sehr wahrscheinlich, eine Verwechselung mit Nr. 3 des Catalogs aber doch noch für möglich S.A.N., 79, 1885, and 80·1915." (*Zweiter Catalog von veränderlichen Sternen*, p. 5).

No. 6. β HYDRI.—3 m. Lacaille; 3-4 Behrmann; 2·7 Gould 3·27 Sir J. Herschel, who says, "Variable?" His estimates of magnitude vary from 3·08 to 3·72. The Cordoba observations, however, do not confirm the suspicion of variation.

No. 7. 11 CETI.—7½ m. Lalande (664-5); 7 m. Harding. Sir W. Herschel gives 10, 11. It is not in the *Uranometria Argentina*, so must have been seen below 7 m. at Cordoba. 3rd October, 1883, I estimated it 7·3 m, from comparisons with W.B. 364 and W.B. 398.

No. 8. 113 P.O. CETI = LALANDE 837.—A double star 7, 9: 44°·6: 19″·6 (7 and 8 m. Gould). Smyth says: "Piazzi tells us that in Flamsteed's asterism, a companion of the 9th magnitude follows this star by 11ˢ·2 of time, which he could not find. There is however, at about the same distance and to the north, a star of this character, although rather smaller. Is the follower then variable?"

No. 9. LACAILLE 144 PHŒNICIS.—The Cordoba estimates vary from 5·7 to 6·5.

No. 10. π ANDROMEDÆ.—4½ Lalande; 4 m. Heis; 5 m. Franks, November 18, 1877; 4·11 Pritchard (1882·685). I found it about 4½ m., and slightly brighter than ϵ Andromedæ, but less than μ, October, 1875.

No. 11. 15 CETI.—7½ and 7 m. Lalande (972–3); 6·8 Gould; Sir W. Herschel, 12·15. 3rd October, 1883, I found it equal to WB 398, or 6·8 m.

No. 12. LALANDE, 1013–14 CASSIOPEIÆ.—5 m. and 10 m. Lalande; 7·7 m. in the *Durchmusterung*. Possibly variable (*Nature*, November 4, 1880), 6 m. Harding. It is not in *Heis' Catalogue*, nor is it in *Fedorenko's Catalogue*, or in *Argelander's Zones*. It was rated 7·9 m. by Knott, and = BD 51°, 131, November 8 and 19, 1880. My observations are:—

November 14, 1880. Faint with binocular, 2 stars about 6½ m. *nf.*

November 20, 1880. Fainter than the two stars *nf.*

August 17, 1883. Fainter than the two stars *nf.*

No. 13.—ANDROMEDÆ.—A small star *s.p.*, the nucleus of the great nebula in Andromedæ (M 31) has been suspected of variation by the Rev. T. W. Webb. He found the star readily visible on several occasions with a 9⅓ inch. With speculum, while at other times he found it very faint with the same instrument (*Ast. Register*, November, 1882).

No. 14. 201 B.A.C. CASSIOPEIÆ = P. 0, 162.—6 m. Argelander and Heis, 6 m. Franks. Seen by me as 6½ or 7 m. in 1874. 5·36 and 5·7 HP.

No. 15. DM 81°,18 CEPHEI.—A little *n.p.* the variable U Cephei; 7·6 m. in the DM. Suspected variable by Pickering. Knott says, "My own observations show that this star is certainly variable to the extent of some six-tenths of a magnitude, but I am unable as yet to see my way to any suggestion as to its probable period." (*Mon. Notices, R.A.S.*, June, 1882).

No. 16. 36 ANDROMEDÆ.—6 and 4½ Lalande (1527-8); 6 m. Harding, 6 m. *Armagh Catalogue* (1840). Not in *Heis' Catalogue*. Webb says, "Visible to naked eye" (*Cel. Obj.* p. 215). Irregularly variable, according to Schmidt. It is a well known binary (6, 7: 356°·2: 1″.3, 1877).

No. 17. γ CASSIOPEIÆ.—3–2 m. Ptolemy and Sufi; 2 m. Argelander and Heis; 2·52 Sir J. Herschel; 2·19 Pritchard (1882·810). In the *Bedford Catalogue* (pp. 21 and 22) Smyth gives some observations of Sir J. Herschel, tending to show variation in the light of this star. Herschel's observations may, however, have been due to the fact that he compared it with α Cassiopeiæ, which is a known variable. It shows a remarkable spectrum with bright lines. 2·3 and 2·2 in HP.

No. 18. 263 B.A.C. PISCIUM. = LALANDE, 1611.—Rated 7½ by Lalande. It is 6 m. in the B.A.C. Franks found it 8 m., and orange (November, 1877). It is not in Birmingham's Catalogue of Red Stars.

No. 19. η ANDROMEDÆ.—4, 4½ Lalande; 5 m. Harding; 4–5 Heis; 5 m. Franks, November 18, 1877; 4·41 Pritchard (1882·677). 4·65 HP.

No. 20. Near μ CASSIOPEIÆ.—Smyth says (*Bedford Catalogue*, p. 25), "Just 18′ south of μ is a star which, though of the 6th magnitude, is not in Piazzi. It is followed nearly on the parallel, about 11ˢ. off, by a 9th magnitude, and both are remarkable for being red, of a decided but not deep tint." In *Nature*, October 21, 1875, the following remarks occur with reference to these stars:—"There is no star of the 6th magnitude near this position at the present time, nor so far as we know is there any record of such an object having been seen since the epoch of Smyth's observations, 1832·71. It may, however, prove to be a variable of long period. . . . . There is now a star of the 9th magnitude following μ Cassiopeiæ 17ˢ·2 and 15′·38″ south; this is clearly Argelander's star + 53°, No. 228 of the *Durchmusterung*, there estimated 9·5, a considerably fainter object than an average 9th magnitude in Bessel's scale; its place would appear to correspond better with that of Smyth's star, following his 6th magnitude nearly on the parallel, than with that of the missing star. Probably this small star may be variable also."

No. 21. β PHOENICIS.—3 m. Lacaille; 3·80 Sir J. Herschel; 3·3 Gould, who suspects variation to the extent of half a magnitude (*U.A.*, p. 271).

No. 22. LALANDE, 2037–8 CASSIOPEIÆ.—Rated 10 m. by Lalande, September 29, 1790, and 8·9 m., December 27, 1790. It is 9 m. in Harding's Atlas, and 7·0 in the *Durchmusterung*.

No. 23. LALANDE, 2097–8 and 2100.—6, and 8 m. Lalande; 8 Harding; 8 m. Piazzi; 7·2 in DM; 6–7 Heis; 7·0 at Cordoba; 8 m. Burnham, January (1875), and 6·5 (1878·865). Suspected variable by Gould (*U. Argentina*, p. 335); and Burnham (*Memoirs R.A.S.*, vol. xlvii, p. 215).

No. 24. ϕ PISCIUM.—A double star, 6, 13 : 226°·5 : 9″·0. Smyth says, "Though marked 'objectum subtile' by Σ, it is steadily seen through my telescope. But it is singular that Piazzi says of it,

"Duplex Comes in eodum verticali, admodum exigua et ad astrum." He certainly could hardly have seen it double with his instrument, as it is now; but the acolyte may be variable." Webb missed the companion.

No. 25. ζ Piscium.—4 m. Sufi; 5 and 4½ Lalande (2187–8); 6 m. Harding; 5–4 Heis; 4·8 Gould; 5½ Franks, November 23, 1877; 4·93 Pritchard (1882·609). A double star, 6, 8 : 63°·8 : 23″·4. Webb says (*Cel. Obj.*, p. 378), "6 var. up to 4 (?)" Smyth (*Bedford Catalogue*, p. 32) says, "The large star may be variable. Ptolemy called it δ in lustre, and he is followed by Ulugh Beigh, Tycho Brahé, and Hevelius." 5·01 and 4·9 HP.

No. 26. 37 Ceti.—6½, 6 m. Lalande (2220–1); 5–6 Heis; 5 Houzeau; 5·3 Gould; 5 Franks, November 20, 1877 (44 = 6 m.). Sir W. Herschel found the sequence 25·37, 28. It was measured 5·1 with the heliometer by Johnson 1851. The Cordoba estimates vary from 5·3 to 5·7. I found it slightly brighter than 44 Ceti in November, 1876. It is 6 m. in the *Cape Catalogue* (1878·91), and 5·02 HP.

No. 27. Lalande, 2416 Ceti.—A double star discovered by Sir John Herschel in 1830, pos. 53°·0, dist. 2″ (measures at Cincinnatti, 1876–78, give 26°·4 : 1″·64). Captain Jacob suspected variation in both components, and rated the star 6–7 m. in 1857. It was estimated only 9 m. by Ormond Stone, 1875. It is 6·7 m. in the *Uranometria Argentina.*

No. 28. ζ Andromedæ.—5 m. Heis; 5 m. Franks (= ω), Nov. 25, 1877. One of Pigott's suspected variables. He says (*Phil. Trans.*, 1786), "This star is said to have diminished in brightness. In 1784 and 1785 I found it, by very exact observations, less than *v*, equal to ω, and brighter than *d* and χ; yet I must mention that it is marked in my journal as being sometimes brighter, and at other times less than ω; but still I am not convinced that it varies in brightness." Pierce measured it as 4·83 (*Harvard College Annals*, vol. ix.). 4·94 HP.

No. 29. DM 8°, 215 Piscium.—In 1881 M. Tempel called attention to the fact that, on January 31 of that year, he could not see this star, but in its place there was a small and faint nebula, the position of which agreed well with that of the star in question. As on one other occasion he has detected such a nebulous appearance in the case of a star which wholly disappeared, and was afterwards again seen by Goldschmidt, M. Tempel suggests that this may indicate the possibility that DM 8°, 215, may again become visible (*Science Observer*, April 12, 1881).

No. 30. 43 Ceti.—6½ m Lalande (2484); 6 Harding. Not in *Heis' Catalogue*, 7·2 m, *Durchmusterung.* The Cordoba estimates vary from 6·6 to 7·3.

No. 31. PISCIUM.—Suspected variable by C. H. F. Peters, from observations at Clinton, U. S. A., 1879–1880. On January 5, 1880, he found it 10 m, but on other occasions much fainter, and sometimes invisible. Probably this star should be transferred to the list of "known" variables.

No. 31*a*. δ CASSIOPEIÆ.—3 m. Ptolemy, Sufi, and Argelander 3, and 4½ Lalande; 3–2 Heis; 3–4 Howzeau; 2·89 Pritchard (1882·810). Gemmill's observations from March, 1882, to October, 1883, vary from 2·7 to 3·2 (*English Mechanic*, February 8, 1884). In October, 1876, I found δ half a magnitude less than γ, and more than half a magnitude brighter than ϵ. 2·84 and 3·0 H.P.

No. 32. LALANDE 2598 CETI.—6½ Lalande; 7 m. Harding; 8 m. Bessel. The estimates at Cordoba vary from 6·5 to 7·8; and Dr. Gould says "this is certainly variable."

No. 33. LALANDE 2677 PISCIUM.—7 m. Lalande, Bessel and 7·0 in the DM: 6–7 Heis; 5·9 Gould, who suspects variation.

No. 34. LALANDE 2798 CETI.—7 m. Lalande; 6·9 m. Gould, who marks it "var. (?)" in the *Uranometria Argentina*, but gives no particulars.

No. 35. 40 CASSIOPEIÆ.—4 m. Lalande, 1789, and 6 m. 1790; 5·2 in the *Durchmusterung*; 4·7 in the first Radcliffe Catalogue; 6 Piazzi; 5–6 Groombridge and Heis (*Nature*, December 30, 1880). Sir W. Herschel gives the sequence, 42, 40, 38. 6 m. Franks, November 25, 1877. 5·46 H.P.

No. 36. 3447 *h* SCULPTORIS = LACAILLE 462 (6m.).—A double star, 6, 7, 90°·6 : 3″, 1887 (O. Stone), and the components are suspected of variation (*Cel. Objects*, App. iii.). Gould calls it τ Sculptoris, and rates it 5·9. 6 m. *Cape Catalogue* (1878·86).

No. 37. LACAILLE 468 ERIDANI.—6 m. Lacaille. Believed to be variable by Gould from 5·9 to 6·5, "or, perhaps, even wider limits."

No. 38. LACAILLE 480 SCULPTORIS.—With reference to this star, Gould remarks, "This appears to be generally below $7^{m}\cdot0$, but has been three times observed as bright as $6^{m}\cdot9$, once by Mr. Hathaway, and twice by Mr. Thome."

No. 39. 42 CASSIOPEIÆ.—Rated 6–7 by Heis, but found by me, December 12, 1876, fully equal to 46 Cassiopeiæ (5 m. Heis); February, 1877, same brightness; March 3, 1883, 42, 1 step less than 46, and 2 steps brighter than 43, or about 5·1 m. Sir W. Herschel found 42, 40, and 48–42–38. 6 m. Franks, November 25, 1877. On September 10, 1883, I estimated 42, 5·3 m.

No. 40. STRUVE 155 PISCIUM.—A double star 7·5, 7·9: 332°·8 : 4″·6. Dembowski thought the components variable.

No. 41. 54 Ceti.—6 m. Lalande; 7½ Bessel; 5·5 in DM; 6·0 Gould (Albany); 6 Heis; 6·2 at Cordoba. Dr. Gould suspects variation, although he includes the star among his "Standards of Magnitude" (*Uranometria Argentina*, p. 21). 5·83 and 5·6 H.P.

No. 42. ζ Ceti.—Rated 3–4 by Sufi; 3 m. by Lalande, Argelander, and Heis; 5 m. Bessel; 3·5 Gould. In November, 1876, I estimated ζ and θ Ceti equal. Sir J. Herschel's estimates make ζ Ceti 0·8 m. fainter than η Ceti, whereas at Cordoba they were rated equal. 3·85 H.P.

No. 43. ϵ Cassiopeiæ.—4 m. Ptolemy and Sufi; 4 m. Lalande; 3 Harding; 3–4 Argelander and Heis; 3·49 Sir. J. Herschel; 3½ m. Franks; 3·51 Pritchard (1882·810), November 25, 1877. In October, 1876, I found it rather more than half a magnitude less than δ Cassiopeiæ. It has also been suspected of variation by Gemmill; his observations from February, 1882, to October, 1883, vary from 3·2 to 3·8 (*Eng. Mechanic*, February 8, 1884). 3·55 H.P.

No. 44. 55 Andromedæ.—6 m. Lalande; 5 Harding; 6 Heis; 5½ Franks, November 25, 1877; measured 5·48 by Pierce; Sir W. Herschel τ, λ·55. Described by Sir W. Herschel as "a fine specimen of a nebulous star." Smyth says (*Bedford Catalogue*, p. 43), "Pigott suspected A of variability." I estimated it 6 m., October, 1875. 5·60 H.P.

No. 45. ξ Piscium.—4 m. Ptolemy, Sufi, Argelander, and Heis; 5½ Lalande and Piazzi; 5 Harding; 4·5 in DM; 4–5 Howzeau; 4·5 Gould (at Albany), and 4·7 at Cordoba; 4·70 Pritchard (1882·623).

No. 46. V. Piscium.—One of Argelander's variables, but rejected by Schönfeld. It is Lalande 3504 (7½ m.). The Cordoba estimates are 6·8 and 7·0 (*U. A.*, p. 335), and in Gould's Catalogue it is marked "var.(?)"

No. 47. 56 Andromedæ = BAC (579 + 580).—6 m. Lalande (3517 and 3524); 5–6 Heis. Struve found the *p* star of this wide pair the smaller; Webb found it the larger 1850, and nearly equal 1871; Whitley and Franks *p* smaller (*Cel. Obj.*, p. 215). 5·74 H.P.

No. 48. 7 Arietis.—7 and 5 m. Lalande (3540–41); 6 m. Harding and Heis; 6 Piazzi, who says, "Quator dierum intervallo ab 8ª ad 6ª magnitudinem stellam hanc transiise mihi visum. Non inde tamen inter variabiles eam referre anderem."

Sir W. Herschel gives 14–7 (which means that he found 7 about 0·4 m. less than 14). My observations are:—"November, 1875, 7 slightly brighter than 1 Arietis, and about 6 m.; February, 1877, 7 a little less than 1 Arietis; December 29, 1877, 7 slightly less than 1; December 23, 1878, 7 slightly less than 1; October 5, 1879, 7 very slightly brighter than 1; November 2, 1882, 7 and 1 exactly equal; September 27, 1883, 7, two steps brighter than 1; January 2, 1884, 7, two steps less than 1.

No. 49. η' HYDRI.—5 and 6 m. Lacaille. The Cordoba estimates vary from 6·6 to 7·5, and Dr. Gould considers it a "variable of long period." 5–6 m. (*Cape Catalogue*, 1874·82).

No. 50. 112 PISCIUM.—6–7 Heis; 6 m. Franks, November 23, 1877, included by Schönfeld in his provisional list. He says (quoting Schmidt), "1867, hell 6 m.; 1869, Aug. nur in Operglase zu sehen, AN 74, 1770." The Cordoba estimates vary from 6·0 to 6·4; March 4, 1877, I found the star mearly 6 m., and brighter than a star *n.f.* α Piscium; December 23, 1878, equal to a star *s.p.*; November 9, 1882, equal to the star *s. p.*; September 30, 1883, 112, two steps less than the star *s.p.* 5·84 H.P.

No. 51. α HYDRI.—2½ m. Lacaille; 3–4 Behrmann; 2·9 Gould; 3·44 Sir J. Herschel, who says "variable (?)" His estimates of magnitude vary from 3·26 to 3·83. It is 3–2 in the *Cape Catalogue* (1873·99). The Cordoba estimates, however, do not confirm the suspicion of variation.

No. 52. α PISCIUM.—A double star 2·8, 3·9 : 324°·0 : 3″·08, 1877. Suspected "variable in brightness and colour" (*Observatory*, October, 1878, p. 186), α was rated 3–4 and 4–3 by Sufi; 3½ by Lalande, and 3–4 by Argelander and Heis. Gould gives it 3·8; Pritchard 3·71 (1882·623). 3.99 H.P.

No. 53. LACAILLE 617 HYDRI.—7 m. Lacaille. Repeatedly observed at Cordoba as 7¼, but twice recorded in 1872 as brighter than 7·0 (*Uranometria Argentina*, p. 242).

No. 54. 61 CETI.—7½ and 6 m. Lalande; 6–7 Heis; 7·3 DM. Sir W. Herschel gives 60–61, 63. Dr. Gould says the various estimates at Cordoba indicate a fluctuation through more than a magnitude (*U. A.*, p. 313). In November, 1876, I found 61 about half a magnitude less than 60, but a little brighter than a star *n.f.*; September 27, 1883, I estimated it 6·0, from comparisons with 60 Ceti and LL 3889 (*n.f.*).

No. 55. ν FORNACIS (= L 618 = LL 3864) 6 m. Lacaille; 6½ Lalande; 5 m. Behrmann; 4 Argelander; 5 Heis. The Cordoba estimates vary from 4·9 to 5·7.

No. 56. α ARIETIS.—This star, according to Gould, shows signs of fluctuation in its light (*U. A.*, p. 342). It was rated 3–2 by Ptolemy and Sufi; twice as 2 m. and three times 3 m. by Lalande; 2·40 by Sir J. Herschel; 2 m. by Argelander and Heis; and 1·9 at Cordoba; 2·16 Pritchard (1883·084 and 1883·175). 2·04 and 2·3 H.P.

No. 57. 55. CASSIOPEIÆ.—6–7 Heis; 6 m. Franks, November 29, 1877. With reference to this star, Houzeau says, "L'etoile 55 Cassiopeiæ était pour moi bien visible et de 6 me. grandeur en 1875·10. Elle est marquée seulement 8·9 dans l'Histoire celéste de Lalande, p. 379." 6·08 and 5·8 H.P.

No. 58. 66 Ceti.—6½ and 6 m. Lalande; 7 Piazzi; 7 Harding; 6–7 Heis. Not in Argelander's *Uranometria;* 6½ m. *Armagh Catalogue;* 6 m. Franks, and = 63, November 28, 1877. Sir W. Herschel found the sequence 58, 66, 63; 6–7 *Cape Catalogue* (1878·96). Gould finds no evidence in support of variation.

November 16, 1876, I found 66 about half a magnitude brighter than 63.
October 21, 1878. Same relative brightness.
September 27, 1883. Estimated 5·6 m. – 4 steps brighter than 63.

No. 59. Lacaille 691 Hydri.—6 m. Lacaille, but found only 7½ m. at Cordoba.

No. 60. Lalande 4339 Persei.—8 m. Lalande; 6·4 DM; 6–7 Heis. Estimated 8 m. by Talmage at Leyton, November 25, 1880, while observing Swift's comet of that year. On January 7, 1882, I estimated it 6·4 m.—about equal to a star *n.f.* (20 Heis Persei).

No. 61. 740 B.A.C. Cassiopeiæ.—With reference to this star, Bailey remarks, "Piazzi considers this star to be of the 8th magnitude only; it was observed by Groombridge (506), who says it is of the 6th magnitude; it was likewise observed by Pond" (74). In *Nature*, July 15, 1875, it is stated that "other estimates are:—Hevelius 6; Fedorenko (Lalande, 1789, November) 8; Piazzi 8, by 7 observations; Schwerd 8½; Taylor, in 1834 or 1835, 7 (he calls the star 21 Cephei); Carrington 8·1; the *Radcliffe Catalogue* 7·5; and *Durchmusterung* 8·4." It was rated 6 m. by Franks, November 30, 1877. On February 14, 1880, I found a small star about 8½ m. near the position; March 14, 1884, small star near position of 740 B.A.C. very faint with binocular, below 9 m.; March 29, 1884—about 9 m.—faint with binocular, in a clear sky.

No. 62. P. II. 89 Trianguli (= 13 F = Σ 269).—A double star, 6·5, 10 : 342°·1 : 2″·3. Webb says, "6·5 var. (?)" Heis naked eye, "Fl. slow bin (?)."

No. 63. 15 Trianguli = 786 BAC.—6½ Lalande (4762); 6–5 Heis; 6 m. Franks, November 29, 1877. In the notes to the BAC, Baily remarks, "Argelander has considered this star to be of the 5th magnitude, whilst Bradley and Piazzi reckon it of the 8th. November 20, 1876, I found 15 slightly brighter than 14 Trianguli; November 15, 1878, 15 very slightly brighter than 14; October 5, 1879, 15 and 14 exactly equal; December 30, 1883, 15 and 14 exactly equal. 5·60 H.P.

No. 64. 79 Ceti.—7 m. Lalande (4810); 6–7 Heis. Not in Argelander's *Uranometria;* 7·0 Gould; 6–7 *Cape Catalogue* (1878·99). (Closely *n.f.* is an 8½ m. star, Lalande, 4821.) February 17, 1884, I found 79 below 7 m.—more than half a magnitude less than LL 5008 (6·5 Gould).

No. 65. LALANDE 4831 CETI.—6½ Lalande; 7 Bessel; 6 Argelander Heis and Gould, and 5·6 at Cordoba. Dr. Gould suspects variation. The star is not in the *Cape Catalogue* (1880).

No. 66. LALANDE 4864–5 PERSEI.—7½ and 9 m. Lalande; 8 m. Harding; 6–7 Heis; 6·7 in DM. Not given by Houzeau.

Jan. 7, 1882. From comparisons with a star (6–7 Heis) south of θ Persei, I estimated the magnitude of Lalande 4864 as 6·5 m.:—

March 6, 1882. LL 4864 about 6·5 m.

April 8, 1883. Estimated 6·6 m.

October 3, 1883. Estimated 6·2 m.

No. 67. 85 CETI.—6½ Lalande (5006); 8 m. Bessel; 6 m. Harding and Heis; 6·5 Gould; 6 m. Franks, November 28, 1877. Dr. Gould suspects variation, although it is included among his Standards of Magnitude (*U.A.*, p. 22). This star is included in Aries, in Lalande's Catalogue. 6·26 and 6·1 H.P.

No. 68. 38 Arietis.—6 m. Lalande (5075); 5 Harding; 5·2 in DM; 5 m. Argelander and Heis; Sir W. Herschel 4·1 (Peirce's reductions); 5·4 Gould; 5 Franks (½ mag. > 31), November 29, 1877. 5·20 H.P.

November 24, 1878, I found 38 brighter than 31 Arietis, but less than λ Ceti; October 14, 1879, 38 brighter than 31, but less than λ Ceti; November 6, 1882, 38 about 5 steps brighter than 31, or about 5·2.

No. 69. LACAILLE 893 HOROLOGII.—5 and 6 m. Lacaille; 6–5 Behrmann; 5·8 Ellery (1870); 6·4 to 6·7 at Cordoba. Gould remarks, "If it be variable, as seems probable, its minimum must have occurred in 1872. The various estimates may be reconciled by supposing a period of somewhat more than 3 years, and a variation of the magnitude from 5·8 to 6·7" (*Uranometria Argentina*, p. 264).

No. 70. π ARIETIS.—A triple star, 5, 8·5, 11 : 121°·6, 109°·9 : 3″·1, 25″. The 11 m. comes seems to be variable, as Sir W. Herschel found it brighter than the 8·5 companion, whereas Webb in 1871 rated them 9·5 and 13. So Sadler, 1874. Franks found 11 more like 13 or 14 in 1876. (*Cel. Obj.*, p. 235).

No. 71. 17 PERSEI.—5 m. Lalande (5242); 5 Heis; 5 Franks (>21 or 24), Nov. 29, 1877. In Pierce's reductions of Sir W. Herschel's estimates the stars 17, 21, and 24 Persei are rated equal, each = 4·9. My observations are:—Nov. 21, 1876, 17 very slightly brighter than 24; Nov. 24, 1878, 17 a little brighter than 24, but less than 16; Oct. 6, 1879, about the same; Sept. 13, '82 about the same; March 4, 1883, 17 three steps brighter than 24, and four steps brighter than 21; Sept. 27, 1883, 17 three steps brighter than 24; Dec. 6, 1883, 17 one step brighter than 24. 4·80 H.P.

No. 72. B. 51 CASSIOPEIÆ (= Arg. + 63, 369); 6·5 Argelander; 8 m Birmingham, April 13, 1876.

No. 73. LACAILLE 937 HOROLOGII.—6 m. Lacaille. Gould thinks that the Cordoba "observations give strong reasons for suspecting variability," the estimates ranging from 6·0 to 6·7. He calls its colour "strikingly red."

No. 74. 21 PERSEI.—4, 5, and 6 m. Lalande (5415–17); 5 m. Heis. 5½ Franks, Nov. 29, 1877. Sir W. Herschel found 21 equal to 17 Persei. Nov. 21, 1876, I found 21 Persei slightly brighter than 17; March 4, 1883, 21 decidedly less than 24 (5–6 Heis)—at least 0·2 mag., and four steps less than 17 Persei, or about mag. 5·6; Dec. 6, 1883, two steps less than 24 Persei. 5·20 and 4·9 H.P.

No. 75. η ERIDANI.—3 m. Ptolemy, Tycho Brahé, and Hevelius; 4–3 Sufi; 4 Ulugh Beigh; 4·50, Sir J. Herschel (*Cape Obs.*, p. 345); 3 m. Heis; 3 m. Franks (Nov. 28, 1877); 3·7 Gould. Smyth remarks (*Bedford Catalogue*, p. 73), "3 pale yellow, and not of a brightness corresponding to its rated magnitude." Jan. 28, 1876, I found $\eta = \epsilon$ Eridani, but slightly less than π Ceti; Nov. 14, 1876, η Eridani slightly brighter than π Ceti. 3·95 H.P.

No. 76. 47 ARIETIS.—6 m. Lalande (5453); 6 m. Harding; 6 m. Heis. Not in Argelander's *Uranometria*; 4·8 Sir W. Herschel (Pierce); 6 m, Franks, Nov. 29, 1877. 5·88 and 5·6 H.P.

Nov. 24, 1878, I found 47 very slightly brighter than ρ^3 Arietis.

Oct. 6, 1879, 47 brighter than ρ^2, but less than ρ^3.

Mar. 3, 1883, 47 two steps *less* than ρ^3.

No. 77. ϵ ARIETIS.—5 m. Sufi; 4½, 5 Lalande; 4 Harding; 6 Bessel; 4–5 Heis and Houzeau; 5·0 Gould; 5 Franks Nov. 29, 1877; 4·24 Pritchard (1882·704). It is a close double star, and Struve suspected the components of variation. Sir W. Herschel gives the sequences $\zeta . \epsilon . \tau^2$ and ϵ , δ. Feb. 1877, I found ϵ brighter than ζ, and not much below δ; March 3, 1883, ϵ 2 steps brighter than ζ. Dr. Gould suspects variation. 4·58 and 4·7 H.P.

No. 78. BRADLEY 396 CASSIOPEIÆ.—4·5 Lalande, Nov., 1789, and 7 m. March, 1790; 7 m. Groombridge; 6 Carrington and Heis; 5·5 in D M (*Nature*, Dec. 30, 1880). March 14, 1884, I estimated it 6·2m., 2 steps less than 784 B.A.C. (6 m. Heis).

No. 79. 5 ERIDANI.—6 and 5½ Lalande (5546–49); 6 Harding; 5–6 Heis; 5·4 Gould; 6 Franks, Nov. 28, 1877. Espin says, "seems liable to sudden changes of magnitude" (*private letter*). Feb. 17, 1884, I estimated it 5·4 m.

No. 80. θ ERIDANI.—3 m. Lacaille; 3–4 Behrmann; 2·6 Gould. A double star, 5, 6: 81°·5: 8″·68 (Sir J. Herschel). The magnitudes of the components seemed to me in the Punjab (1875) much underrated; more like 4 and 5, or 3½ and 4½. As a single star I found it about 3 m., Dec. 1876, and considerably brighter than 12 Eridani.

Gould thinks that one of the components is probably variable to some extent. Sir J. Herschel estimated θ Eridani 3·73, and η Canis Majoris 2·85, or the former 0·88 *fainter* than the latter. Dr. Gould, on the contrary, estimates θ Eridani 0·3 m. *brighter* than η Canis Majoris, which gives further reason for suspecting variation.

No. 81. 93 CETI.—7 and 6 m. Lalande (5617–18); 6–7 Heis; 6·4 Gould. Closely *n* of α, with which it forms a fine open pair. Smyth called 93, 5½ m.

No. 82. ρ^3 ERIDANI.—A double star, 6, 9: 86°·6: 2″·26, discovered by Burnham, who suspects the companion of variation.

No. 83. β PERSEI (Comes).—The well-known companion to Algol, discovered by Schröter (1787), who suspected variation. Sadler considers it variable from 10 m. to 14 m. in some short period. A writer in *Nature* (Feb. 20, 1879) states that he failed to see any trace of the star on several fine nights in the early part of 1874, using a 7-inch refractor; but on Sept. 9 of the same year, he saw the companion very distinctly with the same instrument. It was measured by Talmage at the Leyton Observatory, Oct. 2, 1874 (194°·4, 79″·02; mag. 11–12), and by Burnham 1878·6: 192°·4: 81″·86. There are three other fainter companions.

No. 84. 12 ERIDANI.—3 m. Lalande (5986); 3½ Lacaille (1000); 3–4 Heis; 3·6 Gould (α Fornacis). It is a double star 3, 8: 316°: 2″·4 (O. Stone, 1877), and 3 is suspected of variation. 3·77 H.P.

No. 85. ζ ARIETIS.—4 m. Sufi; 5 Lalande; 6 Bessel; 4·5 in D M; 4–5 Argelander; 5–4 Heis; 4·7 Gould (at Albany), and 5·2 at Cordoba; 4·78 Pritchard (1882·704). Gould suspects variation, although he includes the star among his Standards of Magnitudes (*U. A.*, p. 22). 4·93 H.P.

Oct. 1875, I rated it 5 m. and equal to ϵ Arietis.

Feb. 1877, ζ a little less than ϵ Arietis.

March 3, 1883, ζ 2 steps fainter than ϵ Arietis.

No. 86. κ^1 CETI = 96 Fl.—5½ and 6 m. Lalande; 5 Heis ($\kappa^2 = 6$); 5 Houzeau ($\kappa^2 = 6$ m.); 5·1 Gould (κ^2 (97) = 6·2). Franks found it about 6 m., and very slightly brighter than κ^2 (Nov. 1877) "pale yellow." Nov. 16, 1876, I found κ^1 nearly 1 magnitude brighter than κ^2, and about = 94 Ceti; Jan. 9, 1882, about = 95 Ceti, but less than 94; 4 March, 1883, κ^1 2 steps brighter than 94, and κ^2 3 steps less than 95.

No. 87. χ^1 Fornacis (=Lacaille 1101).—6 Lacaille; 6·2 Gould. The Cordoba estimates varied through six-tenths of a unit. (U. A., p. 125.

No. 88. z Eridani = Lacaille 1125.—5½ m, Lacaille; 6 m. Behrmann; 6·4 Gould; 6–5 *Cape Catalogue* (1877·31). Houzeau says with reference to this star (*Annals of the Brussels Observatory*):—"Le soupçon de variabilité est encore plus fort pour z Eridani, j'ai attribué cette etoile à la 4 me grandeur en 1875·10, et il n'y a pas lieu de croire qu'une erreur grave se soit glissee dans cette estimation. Cette est d'autant moins probable que z est voisine de *e* et de *y* aux quils il avait été alors comparé. Pourtant en 1875·61, je ne le voyais qu'a peine et le notais 6·7. Sur les cartes on l'a fait de la 5 me grandeur, qui est une moyenne. Cette étoile devrait être suivre attentivement par les observateurs."

No. 89. ϵ Eridani.—3–4 Sufi; 3 Argelander, and Heis; 4·40 Sir J. Herschel (*Cape Obs.*, p. 344). Sir W. Herschel found $\epsilon = \eta$; 3·6 Gould 3 m. Franks, Nov. 30, 1877. 3·66 H.P.

Jan. 1876, I found $\epsilon = \eta$, very slightly less than δ, but brighter than ζ.

No. 90. 9 Tauri.—In the *Phil. Trans.*, 1799, p. 142, Sir W. Herschel remarks, "9 Tauri, Dec. 28, 1798. This star is lost. M. de la Lande says it is not to be found. See Mr. Bode's *Art. Jahr. Buch.* for 1795, p. 198. Flamsteed has two complete observations of it, p. 86 and p. 506. We can hardly admit what Mr. Bode suggests that this star, like the rest, has found its way into the British Catalogue by some error of writing, or of calculating the observations; it will, therefore, be advisable to look for a future reappearance of it, as it may prove to be a periodical or changeable one." In the notes to the B.A.C., Baily remarks, "9 Tauri. Sir William Herschel says 'this star is lost.' It is, however, still in its place. Probably it is a variable star." He gives the reduced position for 1690 as A R 49° 41′ 40″, and Dec. 22° 8′ 55″. This position brought up to 1800—the epoch of Lalande's catalogue—agrees fairly well with that of Lalande 6641–2 (7 m.). The star is 7 m. in *Harding's Atlas*, where it is marked 9 Tauri.

Dec. 23, 1878, I found Harding's star less than 7 Tauri, and less than Lalande 6670–71, but brighter than Lalande 6696–7.

Franks rated it 6½ m., and less than 7 or 11 Tauri, Dec. 6, 1877.

No. 91. δ Eridani.—3–4 and 4–3 Sufi; 3 m. Argelander and Heis; 3·3 m. Gould. In Jan. 1876, I found δ very slightly brighter than ϵ Eridani. 3·68 H.P.

No. 92. Maia Pleiadum.—From a careful examination of the magnitudes of the brighter stars in the Pleiades, M. Wolf considers that Merope and Atlas are decidedly variable, and Maia appears to have increased in magnitude since the observations of Piazzi and Bessel. The

five other brighter stars show no evidence of variability, but some of the smaller stars have certainly changed their relative brightness since the former observations. (*Mon. Not. R.A.S.*, Feb. 1876).

No. 93. MEROPE PLEIADUM.—See last note. A faint nebula surrounding this star, discovered by Tempel, 1859, has been suspected of variation, but the evidence is very conflicting. It has been seen by several observers with apertures ranging from 2 inches to 37 inches (Common), but others doubt its existence, notably Burnham, who has failed to see it with the great American refractors. Trouvelot, however, from his own observations, 1875-1880, concludes that the nebula is really variable. (*Science Observer*, Dec. 15, 1881.)

No. 94. 30 (e) TAURI.—5½ and 6 m. Lalande; 5 m. Argelander, Heis, and Houzeau (1875·15); 5·2 Gould (at Albany), and 5·3 at Cordoba; 6 m. Franks, Nov. 30, 1877, "greenish white." On Sept. 27, 1883, I estimated it 5·5 m. (about two steps less than 47 Tauri); April 1, 1884, 5·2 m.

No. 95. ATLAS PLEIADUM.—See note to Maia Pleiadum. Atlas was seen double by Struve in 1830, dist. 0″·79; but Dawes, Secchi, Dembowski, and Burnham have always found it single.

No. 96. ρ FORNACIS.—6 m. Lacaille; 5 m. Argelander and Heis; 5-4 Behrmann. The Cordoba estimates vary from 5·3 to 6·0; 6-5 *Cape Cat.* (1878·71).

No. 97. f ERIDANI.—A double star, 5, 5½: 199°·7: 8″·5. Gould considers that the f star of this pair is probably variable; estimates from 4½ to 6.

No. 98. LALANDE 7172 TAURI.—8½ m. Lalande; 9 m. Harding; 7·8 m. in D M. The Cordoba estimates vary from 6·8 to 7·9, and the star is evidently variable. Sept. 30, 1883, I found this star considerably less than Lalande 7021 (6·8 Gould), and about 7·8 or 8 m.

No. 99. LACAILLE 1286 ERIDANI.—6 m. Lacaille; 6-5 Behrmann; 6·2 Gould, who says, "There is some reason for suspecting variation in the brightness of this star." 6 m. *Cape Catalogue* (1877·64).

No. 100. γ ERIDANI.—3-4 Sufi; 2 m. Lalande and Harding; 3 m. Argelander and Heis; Sir W. Herschel gives the sequence 67 (β), γ–, δ 3·94, Sir J. Herschel (*Cape Obs.* p. 343). He says (p. 179), "marked as 2·3 m. in A.S.C., but it is certainly not above 3–4;" 2·8 Gould. D'Arrest called it "orange;" 3 m. Franks, Nov. 30, 1877. 3·05 as H.P.

Nov. 1875, I estimated it 3½ m.; Dec. 1876, γ seemed about 3 m. and equal to β Eridani.

Secchi found "Spectrum third type; magnificent zones, but certainly variable." (*Addenda to Birmingham's Catalogue.*)

No. 101. P III 213 Tauri.—A triple star, 7·5, 8, 12: 128·1, 240°: 7·2″, 60″; Webb says, "12 var? South missed it, 1823. Σ rated it differently in different years." Chambers remarks, "There seem grounds for supposing C to be variable."

No. 102. Lalande 7737 Eridani.—7 m. Lalande; 6-7 Heis; not in Argelander's *Uranometria*. Found only 7·6 m. at Cordoba. It is not in the *Cape Catalogue* (1880).

No. 103. Lalande 7710 Persei.—6½ Lalande; 5 Harding; 6 m. Heis. 17 March, 1876, I found it about 6½ m.; 3 Nov., 1878, and 12 Nov. 1882, about 6½ m.—less than 56 Persei; 3 Oct., 1883, I estimated it 6·2 m.

No. 104. 47 Tauri.—6½ m. Lalande (7888); 5 m. Argelander and Heis; 6 m. Franks (= 46 Tauri), Dec. 7, 1877, and = P.I.V. 19. It is 5·2 m. in the *Uranometria Argentina*, and marked "red." 4·97 and 4·6 H.P.

Sept. 27, 1883, I found 47 three steps brighter than 46, and two steps brighter than 30 Tauri, but considerably less than μ (or about 5·3 m.).

No. 105. 48 Tauri.—6 and 7 m. Lalande (7926-7); 6 Heis. Included by Schönfeld in his provisional list. He says (quoting Schmidt), "1872, Sept. 3; kaum 7 m., mit freiem Auge keine Spur, langsam zunehmend. U N und Heis 6 m." A N 80, 1912, 1920. 6·39 H.P.

March 21, 1878, 48 about 7·3 m.—1 mag. less than 58 Tauri (6-7 Heis).

Oct. 17, 1878, 48 considerably less than 58, but slightly brighter than a star about 1° *n* of it; 3 March, 1883, 48 about 7 m.; April 2, 1883, 7 m.

No. 106. 121 Heis Persei.—Not in *Lalande's Catalogue;* 7 m. Harding; 6 m. Heis. Not in Argelander's *Uranometria*. Suspected by Pierce (*Harvard College Annals*, vol. ix.) to be variable. He says, "The absence of this star from the *Uranometria*, and the great difference between the magnitude assigned by Heis and me (5·8) and that of the *Durchmusterung* (7·7), certainly creates a suspicion of variability." 7·54 H.P.

I have observed the star as follows:—

Nov. 14, 1878, about 8 m.—equal to or very slightly brighter than a small star closely *s.f.* 12 Nov., 1882, equal to or very slightly brighter than the small star *s.f.*

No. 107. U Tauri.—Included by Schönfeld in his provisional list.

No. 108. 839 H Tauri.—A small nebula discovered by Hind, Oct. 11, 1852, with a 10th magnitude star nearly touching it. This star has since proved to be variable, and is now known as T Tauri (No. 22

of *Catalogue of Known Variables*). The nebula was missed by d'Arrest, Oct. 3, 1861. On June, 26, 1862, Le Verrier could not see it with the 12·4 inch equatorial of the Paris Observatory. Secchi also failed to see it. It was again seen with the 15-inch refractor at Pulkowa, Dec. 29, 1861, and March 22, 1862. Hind and Talmage, however, failed to see it, Dec. 12, 1863, with the telescope with which it was discovered (Chambers' Edition of Smyth's *Bedford Catalogue*, p. 107). Tempel has also failed to see the nebula with 11 inches aperture.

No. 109. θ RETICULI.—6 and 5 m. Lacaille; 5-6 Behrmann; 6·2 Ellery; 6·0 to 6·5 at Cordoba; 6-7 *Cape Catalogue* (1874-88). Considered by Gould to be variable to the extent of at least 0·3 m. It is a double star, 5½, 9: 6°·1: 6″·4 (Sir J. Herschel, 1835).

No. 110. Σ 547 ERIDANI.—Comes suspected by Gledhill to be variable (*Observatory*, March, 1881). It was rated 11·5 by Struve, 1829 and 1832. It was missed by Dembowski in 1865, by Burnham in 1873, 1876, and by Gledhill in 1879; but it was measured by Mädler, 1845, by Burnham 1877·9 and 1879·0, and in 1880 and 1881, and by Gledhill 1880·0 (15°·8 2″·4).

No. 110A. θ^1 and θ^2 TAURI.—4 and 3 m. Lalande; 5 and 5½ Smyth; 4·7 and 5 Struve; 4·5 and 4·5 Argelander; 4 and 4 Heis and Franks; Pritchard measured $\theta^1 = 4{\cdot}13$ and $\theta^2 = 3{\cdot}65$ (thus reversing Struve's magnitudes) (see *Cel. Obj.*, p. 394). March 31, 1884, I estimated θ^1 five steps less than θ^2 with binocular. 3·92 and 3·62 H.P.

No. 111. υ^1 ERIDANI.—(Heis and Behrmann) = υ^6 Lacaille = 50 Fl; 4½ and 5 m. Lacaille; 5 m. Harding; 4 Heis and Behrmann; 4·7 at Cordoba; 5 *Cape Catalogue* (1878·37). Suspected variable by Gould, from observations at Cordoba, where the estimates varied from 4·3 to 5·0. Jan., 1876, I found it less than υ^2 (Heis) Eridani (= 52 Fl.). 4·43 H.P.

No. 112. α TAURI (Aldebaran).—A red star, rated 1 m. by most observers from Ptolemy to Heis; 1.3 m. Gould; 1·12 Pritchard (1883). Espin thinks it variable in colour—yellow to red (*Cel Obj.*, p. 393). Secchi found variations in its spectrum (*Birmingham's Catalogue*, p. 309). 1·00 and 1·2 H.P.

No. 113. ν ERIDANI.—4 m. Sufi; 3-4 Argelander and Heis; 5 m. Houzeau (1875·09); 3·8 Gould; 5 Franks (= μ) Dec. 1877; 5-6 *Cape Catalogue* (1879·05). Taking Gould's estimate of μ Eridani (4·0), I estimated ν as 3·8, Jan. 30, 1883. If we take the H.P. estimate of μ (= 4·31) then my estimate will be 4·11.

No. 114. STRUVE 572 TAURI.—A double star, 6·5, 6·5: 210°·3: 3″·2; the components suspected of variation by Struve. Franks found them only 7 or 7·5, 1877 (*Cel. Objects*, p. 239). It seems to be LL 8693-4 (7, 7½).

No. 115.—ERIDANI.—Closely *n.f.* υ^7 (Lacaille) Eridani (52 Fl.) 6 m. Harding. Not in *Lacaille's Catalogue*. There was no star of 6th magnitude in this position in Feb., 1876, but with 3-inch refractor I found, close to the place, a small star about 10½ or 11 m., which may possibly be variable. Position given only approximate.

No. 116. 53 ERIDANI.—Not given by Ulugh Beigh, Tycho Brahé, or Hevelius; Sir W. Herschel gives 53 , δ; 3½ and 3 m. Lalande (8776-7); 4 m. Harding; 4 m. Heis; 4·1 Gould; 4 m. Franks, Dec. 7, 1877; 4 m. *Cape Catalogue* (1878·63). I found it of a reddish tint, and a little less than μ Leporis, Feb. 17, 1876. 3·89 H.P.

No. 117. 54 ERIDANI.—4½ and 3½ m. Lalande (8860-1); 5 Heis; 6-5 Behrmann; the Cordoba estimates vary from 4·4 to 5·2; 5 m. in *Cape Catalogue* (1878·63). 4·48 H.P.

No. 118. — ERIDANI.—6 m. Harding (underlined); not in *Lalande's Catalogue*. It is situated 20′ due north of the star Lalande 8951. Position only approximate. In Feb., 1876, I found this star only 9 m. and a little fainter than another star a few minutes to the north of it.

No. 119. π^1 ORIONIS.—(π^3 Gould) (= 1 Fl.); 5 and 4½ m. Lalande; 4 m. Argelander; 4-3 Heis; 4 m. Franks, Dec. 7, 1877; 3·62 Pritchard (1881·974 and 1883·040). It was rated 3·4 by Gould at Albany, 3·1 at Cordoba, 1871, but afterwards fainter. Dr. Gould thinks it probably varies by more than a unit in a long period (*U. A.*, p. 325).

March 18, 1876, I found π^1 about ½ mag. brighter than π^3 (Fl.).

March 8, 1883, π about 3·7—more than ½ a mag. brighter than π^3.

No. 120. B. 85 TAURI.—9 m. Bessel; 8·1 Argelander. Birmingham's estimates of magnitude, 1872-1876, vary from 7 to 10; 10 m. Webb, 1874, Jan. 12, 9 m. March 7. I found it below 8 m., 26 Nov. 1878.

No. 121. 60 ERIDANI.—5½ Lalande; 6 m. Heis. It is a red star, and the Cordoba estimates vary from 4·8 to 5·8. 5·19 H.P.

In Nov., 1876, I found 60 a little brighter than 58 Eridani (5·7 m. Gould).

No. 122. LALANDE 9167 ERIDANI (7½ m.)—This star was missed by Bond in 1849 (*Mon. Notices R.A.S.* Nov., 1849). It is 8 m. in *Harding's Atlas*. About 11′ nearly due south of it is Lacaille, 1613 (7 m.), which is not given by Harding or Lalande. There may possibly be some error in the declination observed by either Lacaille or Lalande.

No. 123. o^1 ORIONIS.—No. 87 of *Birmingham's Catalogue*; 5 m. Lalande and Harding; 5 Piazzi; 6 Bessel; 6 Heis; 6 m. Franks (=6 Orionis), Dec. 7, 1877.

No. 124. 5 ORIONIS.—5½ m. Lalande (9183); 6 m. Bessel; 6·5 Piazzi; 6 m. Heis; not in Argelander's *Uranometria*; 6 m. Franks,

Dec. 7, 1877. It is a red star, and No. 88 of *Birmingham's Catalogue;* 5·5 m. Birmingham, 1872, Feb. 10, and 1873, Jan. 22; 7 m. Webb, 1874. The Cordoba estimates vary from 5·6 to 6·6, and Dr. Gould says, "I entertain little doubt of its variability." 5·74 and 5·9 H.P.

March 8, 1883, I estimated it 5·7.

No. 125. W.B. 1025 ORIONIS.—6 m. Harding; 7 m. Bessel and Santini; 5·7 in *Durchmusterung*; 6 m. Heis and Argelander. The Cordoba estimates vary from 6·0 to 6·4. The position given by Gould for this star is 1 minute of R.A., preceding LL. 9243, but agrees with Lalande's star in N.P.D. Harding shows Lalande's star as 7 m., and Gould's star as 6 m. Feb. 24, 1884, I estimated Gould's star 6·1 m., two steps less than 14 Orionis, and one step less than 33; Lalande's star not seen with binocular. 5·57 H.P. and 5·2 "est."

No. 126. π^6 ORIONIS (= Fl. 10 = LL. 9358).—3 m. Ptolemy; 4 m. Sufi; 4½ m. Lalande; 4 m. Harding; 5-4 Argelander and Heis; 4·7 Gould; 5 m. Franks, Dec. 7, 1877; 4·74 Pritchard (1881·976) Schjellerup calls attention to the discrepancy in the magnitudes assigned to this star, in the preface to his translation of Al. Sufi's *Description of the Heavens* (p. 25). 4·72 H.P.

March 18, 1876, I found π^6 much less than π^5, and about 5 m.

March 4, 1883, π^6 equal to ρ Orionis.

No. 127. LALANDE 9420 LEPORIS.—5½ m. Lalande; 6 Harding; 6 m. Heis (in Eridanus); 6·0 Gould; 5·4 Espin (1883). Espin says, "an undoubted variable; probably Class III."—(*private letter*). 5·37 H.P.

No. 128. LALANDE 9418–19 ORIONIS.—A wide double star; 7½, 8 Lalande; 8 Harding; 6 m. Argelander; 6-7 Heis; 6·2 Gould. From the Cordoba observations, compared with those of Lalande, Bessel, and Argelander, Dr. Gould concludes that "one of the components must vary by about a unit." 5·95 H.P.

March 23, 1884, I estimated the star 6·4 m. with binocular.

No. 129. LALANDE 9462 ORIONIS = Birmingham 95.—6½ Lalande; 6m. Schjellerup; 7m. Piazzi; 7m. Bessel; 6m. Argelander and Heis; 5·9. Gould, at Albany (1859), and 6·6 at Cordoba (1872). Birmingham found it 6·5, 1875, Jan. 9, and 1876 Jan. 13, "pale straw colour." Gould calls it "decided orange." March 3, 1884, I estimated it 6·4 m.; March 31, 6·4. 6·20 H.P.

No. 130. 1 LEPORIS.—6½ m. Lalande (9552); 6 m. Harding; not in Argelander's *Uranometria* or *Heis' Catalogue;* 6·1 Gould; 6½ Franks, Dec. 7, 1877 ("deep yellow"). 5·97 H.P.

Jan. 4, 1876, I found it about 6½ m, and just visible to the naked eye in a clear sky (Punjab). It is of an orange tint in the telescope, and is preceded at about 3′ distance by a small star 10½ or 11 m.

No. 131. — Leporis.—6 m. Harding (underlined). Not in *Lalande's* or *Heis' Catalogues.* It is situated a little *n.p.* ϵ Leporis, and between that star and Lalande 9506. Position given in the *Catalogue* only approximate.

Feb., 1876.—With 3-inch refractor I found Harding's star a little brighter than a 9 m. (Harding) south of it, but less than several 8 m. stars (Harding) following. It has a small companion *f* about 1′ ± distant.

No. 132. ϵ Leporis.—4 m. Lalande; 3·84 Sir J. Herschel (*Cape Obs.* p. 344); 4-3 Heis; 3-4 Behrmann; 3·1 Gould, who marks it "var. (?)" but gives no particulars; 4 m. Franks, December 7, 1877. 3·26 H.P.

No. 133. Lalande 9667 Eridani.—Rated 8 m. by Lalande; 7 m. Bessel. According to Gould it is generally below 7½ m., but it was once observed by Mr. Rock as 6·9 (*Uranometria Argentina,* p. 273).

March 3, 1884, I found it more than a magnitude less than LL 9706 (closely *f.*), and therefore below 7½ m.

No. 134. β Eridani.—4 m. Sufi; 3 m Lalande, Argelander, and Heis. Sir W. Herschel gives the sequence β, γ —, δ; 3·26 Sir J. Herschel (his estimates vary from 3·06 to 3·55); 2·8 Gould, who suspects variation to the extent of half a magnitude. 3½ m. Franks, December 12, 1877. 2·87 H.P.

March 3, 1884, I estimated it 2·9.

No. 135. λ Eridani.—4 and 4½ Lalande; 5 Harding; 4 Heis; 4·6 Gould, 4·97 Sir J. Herschel; 4½ m. Franks, December 12, 1877; 4 m. *Cape Catalogue* (1878·99). 4·39 H.P.

March, 18, 1875, I found it equal to ω Eridani, brighter than ψ Eridani, but not quite equal to τ Orionis (4 m. Heis); March 3, 1884, I estimated it 4·6.

No. 136. Lalande 9767 Eridani.—8 m. Lalande and Bessel; 7·8 in D M. The Cordoba estimates were 6·7, 6·8, and 7·0. On March 3, 1884, I estimated this star 6·8—about = LL 9699; March 31, 6·9.

No. 137. Birmingham II 16 Leporis.—According to Sadler this is Piazzi V. 7 and W.B.V. 78, in both of which catalogues it is 7 m. It is Lalande 9785 (6½ m.). In Stone's *Southern Catalogue* it is rated 5-6 m. (1878·76). It is not given by Argelander or Heis; 6·0 Gould. It was rated 5 m. by Morton, 1856; 6 m. Sadler, February, 1875; 6·5 Winnecke, December, 1875; estimated 7 m. by me, January, 1877; 7·2 Espin, December, 1877, and 6·5 December, 1879; 5-6 m. Cornish, January, 1880, "fairly bright to naked eye." Flammarion says, "Elle est certainement variable." It precedes ι Leporis by 55·24 seconds, and is 53″·25 to the north of it.

No. 138. ρ ORIONIS.—Not in *Lalande's Catalogue*; 5 m. Harding, Heis, and Franks. The Cordoba estimates vary from 4·6 to 5·1. 4·47 and 4·8 H.P.

March 4, 1883, I found $\rho = \pi^6$ Orionis or 4·7; March 8, 1883, one step less than π^6, or 4·8.

No. 139. α AURIGÆ (Capella).—Struve in a letter to Sir J. Herschel, December, 1838, stated that he considered Capella was increasing in brightness, and Sir J. Herschel agrees with him (*Cape Obs.*, p. 350). From observations made by Mr. Benedict Ellner, of Bamberg, Bavaria, in 1855, he found that Capella varied in brightness (1·0 to 1·9), and also in colour (from "whitish yellow" to "red.") (*Ast. Register*, September, 1875). Pierce measured it 0·09 with the photometer (Seidel's estimate being 0.33, and Zöllner's 0·20). Pritchard 0·08 at Oxford (1883), and 0·09 at Cairo (1883). 0·18 and 0·3 H.P.

No. 140. β ORIONIS (Rigel).—Dr. Gould suspects slight fluctuations of brilliancy in this bright star. At Cordoba it was sometimes estimated equal to or a little fainter than α Eridani (1·0 m.), while at other times it was found decidedly brighter than α Centauri (0·7 m.) (*U.A.*, p. 341). In Professor Pritchard's photometer results it is rated 0·03 at Oxford (1883) and −0·08 at Cairo (1883). 0·32 H.P.

No. 141. 16 AURIGÆ.—Noted by me as a reddish star in November, 1878 (*Observatory*, December, 1878); not in *Birmingham's Catalogue*; Franks estimated it 5 m., and fine orange, December 14, 1877, and suspects variation, but his magnitude agrees with the estimates of Argelander, Heis, and Houzeau (1875·16), who all rate it 5 m. Sir W. Herschel gives the sequence 16 , 14·19. March 31, 1884, I estimated it 4·9—four steps brighter than 14. 4·97 H.P.

No. 142. B. 103 AURIGÆ.—7 m. Schjellerup; 9 m. d'Arrest (non utique lucidior); 7-8 Birmingham, February 2, 1873. Not found as a red star by Webb, 1874, March 26 (*Birmingham's Catalogue*, p. 265).

No. 143. 109 TAURI.—5½ , 6 Lalande (9909-10); 6 m. Argelander; 6-5 Heis; 5-6 Houzeau (*n*) (1875·13); 5 m. Franks, "pale yellow" = 114. I found 109 one step less than 114 Tauri (6 m. Heis) February 3, 1884; February 14, 1884, two steps less than 114, and one step less than 97 Tauri. 5·15 and 5·3 H.P.

No. 144. 21 ORIONIS.—6 and 5½ Lalande (9953-4); 5 Harding; 6 Heis; 6 m. Franks, December 13, 1877. The Cordoba estimates vary from 5·6 to 6·0. November 24, 1878, I found 21 brighter than Lalande 9878; March 4, 1883, 21 two steps brighter than W B 64 (6·3 Gould; February 22, 1884, 21 = 38, but brighter than 33 Orionis, or 5·8 m.; March 23, 1884, 21 = 33, or 6·0. 5·37 and 5·6 H.P.

No. 145. B.A.C. 1661 ORIONIS (8 m.)—Baily says, "Taylor considers the magnitude of this star to be variable." It is Lalande 10052 (8), and lies closely *p* 23 Orionis, November 24, 1878, I found it small with binocular, about 8 m.; March 6, 1883, very small with binocular—less than 8 m.

No. 146. LALANDE 10159 ORIONIS.—A faint and close companion to this star was discovered by Burnham, who suspects the bright star of variation, as it is not found in the catalogues of Bode, B.A.C., Schjellerup, Weisse, Yarnall, Rumker, or Lamont. It is 8 m. in *Lalande's Catalogue*, but was rated 6½m. by Burnham (*Memoirs R.A.S.*, vol. xliv., p. 178). It is not in the *Uranometria Argentina*. Near η, *sf*. March 4, 1883, I found it very small and barely visible with the binocular.

No. 147. γ ORIONIS.—2 m. Sufi, Lalande, Argelander, and Heis; 2·10 Sir J. Herschel, who says "Variable (?)" His estimates of magnitude vary from 1·77 to 2·42. It was rated 1·7 m. at Cordoba, and Dr. Gould marks it "var. (?)" Pritchard gives 1·79 (1882·073). 1·86 H.P.

No. 148. β LEPORIS.—3-4 Sufi; 3 m. Lalande; 3-4 Argelander and Heis; 3 m. Behrmann; 4 m. Franks, December 12, 1877; 3·35 Sir J. Herschel, who says "probably variable." His estimates of magnitude vary from 2·97 to 3·72. Sir W. Herschel found β less than α, but slightly brighter than μ Leporis. The Cordoba estimates vary only from 2·8 to 3·0. 3·03 H.P.

December 6, 1875, I found β and α Leporis nearly equal, perhaps α very slightly the brighter; March 17, 1876, α and β exactly equal, and about 3 m.; January 22, 1877, α Leporis slightly brighter than β.

No. 149. 1706 B.A.C. CAMELOPARDALIS (*Comptes Rendus*, vol. liii., p. 479).—Not in *Heis' Catalogue*. It seems to be No. 966 of *Groombridge's Catalogue* (5 m.) February 24, 1884, I estimated it 6·7 m.—two steps less than 1619 B.A.C.

No. 151. 119 TAURI.—5 m. Sufi; 5½ Lalande (10367); 4·4 Argelander; 5 m. Heis; 5·5 Birmingham, orange. I found it very reddish with binocular, November 21, 1878; January 31, 1884, I estimated it 4·5 (μ Tauri = 4·6) and reddish. 4·57 and 4·9 H.P.

No. 152. 1727 B.A.C. AURIGÆ.—In the notes to the B.A.C., Baily remarks, "Taylor considers this star to be variable." It is Lalande 10357 (7 m.); 7 m. Harding; closely *nf* χ Aurigæ. October 30, 1878, I found this star equal to Lalande 10419; March 31, 1884, estimated 6·8 m., three steps brighter than LL 10419.

No. 153. *Durchmusterung* 45°, 1222 AURIGÆ.—Estimated 8·6 m. by Espin from a photograph, March 10, 1884, but not found by him on a photographic plate taken a few nights later. The star is 7·5 m. in the *Durchmusterung*, and seems to be identical with Lalande 10355

($8\frac{1}{2}$ m.). It is 9 m. in *Harding's Atlas.* On similar grounds Espin suspects variation in a star in Leo Minor DM 33°, 1895). (*See* "Supplementary List.") (*See* Espin's "Catalogue of the Magnitudes of 500 Stars."—*Proceedings of the Liverpool Astronomical Society,* 1884).

No. 154. ANON TAURI.—Found by Schmidt to vary from 8-9 to 11-12 (1861-1864) (*Ast. Nach.*, 1513).

No. 155. λ ORIONIS.—4 m. Lalande; 4·05 Sir J. Herschel (*Cape Obs.*, p. 346); 3-4 Heis. Gould considers this star probably variable to the extent of more than half a magnitude; 3·52 Pritchard (1883·040). March 18, 1876, I found λ equal to η Orionis, and about half a magnitude less than ι Orionis (3-4 Heis). 3·49 and 3·8 H.P.

No. 156. LACAILLE 1890 COLUMBÆ.—6 m. Lacaille. According to Gould this star, which is red, was once reported by Gilliss to be missing, although it is in his *Santiago Catalogue.* It was also observed by Piazzi, Brisbane, and Taylor. The Cordoba estimates vary from 6·2 to 6·7 (*Uranometria Argentina*, p. 292).

No. 157. 42 ORIONIS.—4 m. Sufi (30th star of Orion.); 6 m. Lalande (10540). Heis rated 42 and 45 together as 5–4. Gould suspects variation in either 42 or 45, from observations at Cordoba. 4·60 H.P.

No. 158. LALANDE 10527 ORIONIS.—Rated 8 m. by Lalande, and suspected by Falb and Gould to be variable. It is a double star Σ 747 (LL 10527 and 10529). It lies closely *s.p.* ι Orionis, and I have often seen it with the naked eye in the Punjab sky in full moonlight.

From the Cordoba observations, Dr. Gould concludes that LL 10527 varies between $5\frac{1}{2}$ and $7\frac{1}{2}$, while LL 10529 remains nearly constant (*Uranometria Argentina*, p. 329). The proximity of the star to ι Orionis renders observations difficult. March 8, 1883, I found this star, with binocular, less than υ Orionis, but brighter than 49 Orionis, or about mag. 5·2; February 22, 1884, one step less than 49, or 5·3 m. 4·47 H.P.

No. 159. ANON ORIONIS.—Estimated 6·7 to 7·0 at Cordoba; but not found by Dr. Gould in any of the Catalogues, with exception of one by Schmidt, where it is given as 8 m. Gould says, "It is brighter than W. B. V. 732 by a full unit of magnitude" (*U. A.*, p. 329). February 22, 1884, I estimated it 6·9 m.; two steps less than a star *s.f.* (123 of Orion, Gould).

No. 160. 45 ORIONIS.—7 m. Lalande (10555). Heis rated 42 and 45 together as 5–4. Between the two is an 8 m. star, Lalande 10547. Gould suspects variation in either 42 or 45, from observations at Cordoba. 4·95 H.P.

No. 161. Near θ ORIONIS.—This is No. 822 of *Bond's Catalogue of Stars* in the great Orion nebula. In April, 1878, it was observed by Schmidt to vary from 9·7 to 12·8 m. The variability was also detected by Common in 1883.

There are several other faint stars suspected of variation in the vicinity of the "trapezium" (see *Observatory*, November and December, 1880).

The 5th and 6th stars of the "trapezium" have also been suspected of variability by O. Struve and others, but Burnham considers that there is no evidence of change.

No. 162. σ ORIONIS (COMES).—The 11 m. star preceding the principal star of the group. It escaped observation by Sir W. Herschel, but it has been seen by Ward with 2⅞ inches aperture; and I found it plain enough with 3·9 inches in the Punjab, 1874. In March, 1883, Baxendell observed it of unusual brightness.

No. 163. α COLUMBÆ.—2 m. Lacaille; 3·15 Sir. J. Herschel (α Hydri = 3·44). Estimated 2·9 at Cordoba in 1870, and 2·4 in 1872–73 (*U. Argentina*, p. 292).

No. 164. BIRMINGHAM 118 ORIONIS.—8 m. Lalande (10785); 8 Bessel; 7·7 Schjellerup; 7·8 Argelander; 6·8 Gould; 7·3 Birmingham, who says "blue in several observations." Schjellerup noted its colour as "roth," but afterwards found it "not red." Gould says "the colour is decidedly red" (*Uranometria Argentina*, p. 330).

No. 165. BIRMINGHAM 120 TAURI.—8·5 Argelander; 8 m. *Markree Catalogue*. *Birmingham's Observations* 8 to 9·5. He says, "Decidedly variable." It is not in *Lalande's Catalogue*.

No. 166. BIRMINGHAM 121 GEMINORUM.—7·7 Argelander; 8 m. *Markree Catalogue*. *Birmingham's Observations*, 1876, 7·7 m. (January 21); and 7 m. (February 19). He says, "Probably variable."

No. 167. 132 TAURI.—4½, 5½, and 6 m. Lalande (10966–8); 5 Harding; 5–6 Heis); 5 Franks, December 14, 1877. Not in *Birmingham's Catalogue*. I have observed this star as follows:—

February 18, 1878, 132 brighter than 139 (5–6 Heis)—of an orange hue with binocular; November 21, 1878, 132 rather *less* than 139; very slightly brighter than 125 (6 Heis); December 21, 1878, 132 about ¼ mag. less than 139, and about = 125; January 11, 1879, same relative magnitudes as on December 21, 1878; February 8, 1880' 132, about two steps less than 139, but two steps brighter than 125; December 30, 1883, 132 two steps less than 139, but two steps brighter than 125. 5·09 and 4·9 H.P.

No. 168. κ ORIONIS.—3–4 Sufi; 3 Lalande; 3–2 Argelander and Heis; 2·59 Sir J. Herschel (*Cape. Obs.*, p. 445); 2·3 Gould, who thinks it slightly variable. March 31, 1884; from comparisons with ζ and ι Orionis, I estimated it 2·1 m. 2·22 and 2·4 H.P.

No. 169. υ AURIGÆ.—5 and 5½ m. Lalande; 5 m. Heis; 5½ Franks, December 14, 1877; suspected variable by Espin (*English Mechanic*, April 8, 1881), who has made the following observations:—March 11, 1879, 4·3 m.; March 16, 4·8; October 26, 4·7; November 1, 4·7; April 14, 1880, 5·0; September 2, 5·0; March 17, 1881, 5·0; March 28, 5·3; March 30, 5·4; April 2, 1881, 5·4.

My observations are:—October, 1875, υ about 5 m., slightly fainter than τ; April 2, 1883, υ one step brighter than τ, or 4·7 m.; September 30, 1883, three steps less than τ or 5·0; November 3, 1883, two steps less than τ, or 5·0; December 30, 1883, 5·0; March 7, 1884, 4·7; March 17, 1884, 5·0; April 1, 4·7; April 7, 4·7.

No. 170. 56 ORIONIS.—6 m. Lalande (11125); 6–5 Heis; 6 m. Franks, December 13, 1877; 5·5 Albany observations; 4·9 Thome, at Cordoba. On March 8, 1883, I found it equal to LL 11382, and four steps brighter than LL 11621, or about 5·5 m.; March 23, 1884, 5·3 m.; April 1, 5·3. 4·97 H.P.

No. 171. LACAILLE 2080 PICTORIS.—5 and 6 m. Lacaille; 6-5 Behrmann. The Cordoba observations show signs of variation.

No. 172. π AURIGÆ.—Not mentioned by Sufi; 6 m. Lalande; 5 Harding; 4·8 Argelander; 5 Heis; measured 4·36 by Peirce (*Harvard Annals*, Vol. IX.); 5 m. Birmingham, 1873, February 2; and 6 m. 1875, January 25; 6 m. Webb, 1874, March 6, and 26; 5½ m. Franks, December 24, 1877. In November, 1875, I found it about 5 m. or 5½; September 10, 1883, I found $\pi = \nu$ Aurigæ or 4·2; November 3, 1883, π two steps less than ν, or 4·4; March 7, 1884, two steps brighter than τ, or 4·6; March 17, 1884, $\pi = \tau$, or 4·8; April 1, 1884, 4·5—a mean between ν and τ Aurigæ; April 7, 4·4.

No. 173. LALANDE 11382 ORIONIS.—6½ m. Lalande; 5–6 Argelander; 6–5 Heis. The Cordoba estimates vary from 5·1 to 5·9; March 8, 1883, I estimated it 5·5 m., four steps brighter than LL 11621, and about = 56 Orionis; March 13, 1884, 5·4 m.; and March 31, 5·2, five steps brighter than LL 10734.

No. 174. 35 AURIGÆ.—Sometimes, but erroneously, called 35 Camelopardi. It is 1924 B.A.C., and a double star (7,10 : 14°·4 : 30″, and Dembowski called attention to the probable variability of the brighter component (*Nature*, December 30, 1880). It was rated 5½ m. by Flamsteed in 1696; 5–6 Lalande, 1790; 7 m. Harding; 8 m. Argelander, 1842; 5·5 Dembowski, 1868; 7·5 *Radcliffe Observations*, 1870; 6–7 Heis; 6·0 *Radcliffe Observations*, 1872; 6 m. Franks, December

24, 1877. My observations are:—October, 1875, about 6½ m., and fainter than *o* (27) Aurigæ; January 31, 1878, equal to a star *f.*, and brighter than the other stars in the immediate vicinity; October 6, 1879, about 1 mag. less than *o* Aurigæ; January 9, 1882, two steps less than the star *f*; April 2, 1883, two steps less than the star *f.*—at least 1 mag. less than *o* Aurigæ; March 4, 1884, I estimated it 6·3 m., two and a-half steps less than 85 Heis Aurigæ.

No. 175. 39 Aurigæ.—7 m. Lalande (11406); 6–7 Heis (38 = 6 m.); 6 m. *Armagh Catalogue;* 5·90 Pierce—measured (38=6·07). Sir W. Herschel gives the sequence 39·38–42. 38 is rated brighter than 39 in the *Durchmusterung*. My observations are as follows:—March 21, 1876, 39 slightly brighter than 38; November 20, 1876, 39 about half a magnitude brighter than 38; March 31, 1877, 39 and 38 nearly equal; October 28, 1877, 39 about ¼ magnitude brighter than 38; November 17, 1878, 39 about ¼ magnitude the brighter; October 7, 1879, 39 nearly ½ magnitude the brighter; December 7, 1879, 39 three steps brighter than 38; December 1, 1880, 39 two steps the brighter; September 18, 1881, 39 two steps the brighter; January 9, 1882, 39 four steps the brighter; September 13, 1882, 39 three steps the brighter; October 15, 1882, 39 three steps the brighter; March 4, 1883, 39 three steps brighter than 38; October 3, 1883, 39 four steps the brighter; November, 20, 1883, 39 four steps the brighter; February 22, 1884, 39 six steps the brighter; March 4, 1884, 39 three steps brighter than 38, but two steps less than 36 Aurigæ; April 1, 1884, 39 two steps brighter than 38.

No. 176. Lacaille 2145 Pictoris.—6 m. Lacaille; 6·9 Gould (No. 3 of Puppis). Tebbutt says it is "certainly variable." It is a double star, and Tebbutt rates the components as 8¼ and 8½, and distance 2″·5, and adds—"In the Catalogues of Lacaille and Brisbane and the British Association the star is set down as of the sixth magnitude, whereas at the date of my measures (1881·214) neither of the components could be seen in so small an instrument as that employed by Lacaille" (*Observatory*, July, 1881). It seems to be No. 34 of Pictor in *Behrmann's Catalogue*, where it is rated 6 m. Sir J. Herschel rated the components 7 and 7½, and calls it a "superb double star" (*Cape Obs.*, p. 187).

No. 177. 19 Leporis.—6 m. Lalande (11700); 6 m. Harding; 5 and 6 m. Argelander-Oeltzen; 5·9 Gould; 4 m. in Stone's *Cape Catalogue* (1880); 6 m. Heis; not in Argelander's *Uranometria*. Rated 7 m by Tebbutt (N. S. Wales, Feb. 12, 1883) while observing the Great Comet of 1882 (*Observatory*, May, 1883); 6 m. Franks, December 31, 1877. 5·53 H.P.

No. 178. W. B. VI. 58 Leporis.—Observed by Bessel as 6 m. in 1825. It is not in *Lalande's Catalogue* or *Harding's Atlas*, and no observations were recorded by d'Agelet, Lamont, and other observers

(*Nature*, May 29, 1875). It is 6–7 in *Heis's Catalogue*, but it is not in Argelander's *Uranometria*. It is 6·0 m. in the *Uranometria Argentina*, where it is marked "red." I found the star about 6 or 6½ m. January 13, 1875. It is of a reddish hue, and is in the same low power field with, *n* of and a little *p*, the star Lalande 11778. 5·68 H.P.

No. 179. LACAILLE 2168 LEPORIS.—6½ Lacaille; 7 Argelander; 6 m. Behrmann; 7½ m. Yarnell; 6–7 *Cape Catalogue* (1878·08). The Cordoba estimates vary from 5·9 to 6·4 (*U. A.* p. 309).

No. 180. LALANDE 11884 ORIONIS.—8½ Lalande; 6·3 in *Durchmusterung*; 6 Argelander and Heis; 6·1 Gould at Albany; and 6·6 at Cordoba. Gould suspects variation (*U. A.* p. 25). February 14, 1884, I estimated it four steps less than 73 Orionis, and equal to Lalande 11217, or 6·4 m.; March 31, 1884, 6·6 m.

No. 181. BIRMINGHAM 141 AURIGÆ = Arg. + 39°, 1576; 6·9 m. Argelander; 8 m., Birmingham, December 12, 1873, and 7–7·5 May 3, 1876. It is not in *Lalande's Catalogue*.

No. 182. W. B. 265 ORIONIS.—7 m. Lalande (12018); 7 m. Bessel and Santini; 7½ Piazzi; 6·5 D.M. Not given by Heis. The Cordoba estimates vary from 6·1 to 6·5, and Dr. Gould says, "I entertain small doubt of its variability by more than half a unit at the least." Lalande's R.A. is one minute too large. March 3, 1884, about = 66 Orionis, or 6·2 m.—brighter than LL 11923; April 1, 1884, 6·2 m.

No. 183. LALANDE 12104 ORIONIS.—6 m. Lalande, Argelander, and Heis; 5·4 Gould (at Albany). Gould suspects variations from 5·4 to 5·9. It was also suspected to be variable by Birmingham in February, 1873. In February, 1875, I found the star just visible to the naked eye (Punjab); March 8, 1883, 5·4, three steps brighter than 60 Orionis; April 1, 1884, 5·6.

No. 184. BIRMINGHAM 144 GEMINORUM.—7 and 6½ Lalande (12245–6); Birmingham's Observations (1872–1876) vary from 6·5 to 8. He says, "This star seems decidedly variable" (8·3 Webb, February 14, 1874). February 28, 1878, I estimated it 7·2 m.; February 14, 1878, 7·2; April 2, 1883, 6·8; March 24, 1884, 6·6; March 31, 6·6. This star seems certainly variable.

No. 185. α ARGUS (Canopus).—This fine star, second only to Sirius in brilliancy, does not rise above the English horizon. Webb says, "It was thought, 1861, in Chili, brighter than Sirius (*Ast. Nach*, 1311)."

Though attaining a meridian altitude of only 7° at my station in the Punjab, I observed it several times in 1874 to be very little inferior to Sirius. It may be variable, and should be watched by Southern observers. It was rated at Cordoba 0·4, Sirius being 0·1, and Vega 1·0 on the same scale.

No. 186. BIRMINGHAM 147 MONOCEROTIS = Lalande 12481 (8 m.); 8 Harding; 8 m. Bessel; 9 m. on Bremiker's chart. Birmingham's Observations, 1873–1876, vary from 5–6 to 8. He says, "Seems decidedly variable." I cannot find any allusion to this star in the *Uranometria Argentina*, although it was observed on several occasions by Birmingham as 6 m. in the years 1873–1876. My own observations are:—March 4, 1878, 7½ m.—less than a 7 m. *p*; December 24, 1878, faint, about 8 m.; February 14, 1880, about four steps less than the star *p*, or 7·1 m.; April 2, 1883, estimated 7·3 m.; April 1, 1884, faint, about 8 m.

No. 187. 12 MONOCEROTIS.—6½ m. Lalande (12531); 6 Harding; 6 Heis; 5 m. Argelander; 5 m. Houzeau; 6·0 Gould (at Albany) and 6·2 to 6·5 at Cordoba; 6 m. Franks, December 31, 1877. It is situated in the star cluster ♅. VII. 2. Gould calls it a "red star." March 8, 1883, I estimated its magnitude as 5·9; March 23, 1884, 6·3 m.

No. 188. O. A. 5270 CANIS MAJORIS.—6 m. Harding rated 6 m. by Heis (No. 18), but only 8½ and 9 m. by Argelander, and 9 and 9½ m. at Cordoba. 5.74 H.P.

No. 189. LALANDE 12699 MONOCEROTIS.—7½ m. Lalande; 6·5 in D. M.; 6 m. Argelander and Heis; 6·7 at Cordoba. Gould suspects variation. I found it brighter than LL. 12788, in February 1877; on March 23, 1884, I estimated it 6·3, two steps brighter than 16 Monocerotis. It is 6·04 aud 5·7 in the H.P.

No. 190. ν^1 CANIS MAJORIS.—Not in *Lalande's Catalogue;* 6–7 Heis; 6·4 Gould; 6 m. *Cape Catalogue* (1879·03). A double star, 6·5, 8: 260°·2 : 17″.2. Smith called 6·5 "pale garnet" (*Bedford Catalogue*). Birmingham says that Main found it "white," March 1, 1863.

No. 191. ν^2 CANIS MAJORIS.—3½, 4 Lalande; 5 Harding; 5 Heis; 4·75 Sir J. Herschel; 4·1 Gould; 4 m. *Cape Catalogue* (1879·05). January, 1876, I found it brighter than ν^3, and a little brighter than θ Canis Majoris. (4–5 Heis). 4·25 H.P.

No. 192. ν^3 CANIS MAJORIS.—4½ Lalande; 6 m. Argelander and Heis; 6 m. *Cape Catalogue* (1879·06). Dr. Gould calls it "red" and rates it 4·9. In January, 1876, I found it less than ν^2. 4·68 H.P.

No. 193. LALANDE 12788 MONOCEROTIS.—6½ m. Lalande; 6 Harding; 8 m. Piazzi. In February, 1877, I estimated it 8 m.—less than LL 12699, and LL 12852; January 31, 1878, 8 m. or 8·2; March 23, 1884, estimated 8½ m., about 1 mag. less than LL 12852, and faint with binocular in a very clear sky.

No. 194. P.VI 174 LYNCIS.—A double star 7½, 10 : 134·2 : 4″·0. Smyth says (*Bedford Catalogue*, p. 155): "This delicate object was

discovered by Σ, and is No. 946 of the Great Dorpat Catalogue. S. measured it in 1825, and from the difficulty he experienced I expected to find the companion much smaller than I did. It appeared to him of the 12th magnitude, and Σ, from finding it 8.5 in 1827, 10 in 1831, and 8·5 again two years afterwards, asks *Num minor variabilis?* . . . . But the possibility of the *comes* being variable awakens considerations of peculiar interest; it having been surmised that certain small acolyte stars shine by reflected light."

No. 195. LALANDE 12863 MONOCEROTIS.—Rated 8½ and 6½ by Lalande; 6 m. Harding; 6 m. Argelander; 6–7 Heis, and 7·3 in the *Durchmusterung*. It is not given by Piazzi, Bessel, or Santini (*Nature*, January 25, 1877). It is 6·7 in the *Uranometria Argentina*.

In February, 1877, and Jan. 1878, I found this star brighter than Lalande 12810–11 and 12852–3, which lie close to it, and about half a magnitude less than 16 Monocerotis (6 m. Heis). It is at the *n.f.* corner of a trapezium of four stars, that at the *s.p.* corner being Lalande 12788; March 23, 1884, I estimated it 6·8 m.

No. 196. 33 GEMINORUM.—6½ Lalande (13108); 6 m. Heis; Sir W. Herschel 35, 33, November 24, 1878, I found it slightly less than 26 Geminorum. March 31, 1883, 33 about three steps less than 26.

No. 197. 35 GEMINORUM.—6 m. Lalande (13140); 6–7 Heis. Nov. 24, 1878, Sir W. Herschel gives 38 (e), 35, 32 and 35, 33. I found it about 6–7 m., and slightly less than 33; December 7, 1879, 35 considerably less than 30 and 38; March 31, 1883, 35 one step brighter than 33, but considerably less than 30 and 38.

No. 198. LACAILLE 2470 CANIS MAJORIS.—6½ Lacaille; 7 Harding; 7 and 7½ Argelander; 6 m. Heis; 8·2 Johnson; 7·5 Yarnell; 7–6 *Cape Catalogue* (1878·14). The Cordoba estimates varied from 7·0 m. to 8 m.

No. 199. 38 (e) GEMINORUM.—5½ m. Lalande; 5 Heis; 5 m. Franks; December 31, 1877, Sir W. Herschel gives 30 (ξ^1). 38–35. One of Mädler's suspected variables. It is a double star, 5·5,8 : 163°·8 : 6″·4, and variation has been suspected in both components, the brighter star having been variously estimated by different observers from 5·0 to 6·7, and the smaller from 7·5 to 10·5; November 20, 1883, I found 38 = 30 Geminorum. 4·28 H.P.

No. 200. θ CANIS MAJORIS.—5 m. Lalande; 4–5 Heis; 4·68 Sir J. Herschel; 4·4 Gould; Sir W. Herschel gives 14 (θ), 20 (ι); 4–5 *Cape Catalogue* (1874·55). Suspected variable by Espin, and also by Schmidt, who calls it "very red." It is No. 156 of *Birmingham's Catalogue;* 4½ m. Franks, December 31, 1877. In January, 1876, I found θ slightly less than ι (5·4 Heis), also less than ν^2 Canis Majoris.

No. 201. o^1 Canis Majoris.—4 m. Lalande; 5 Lacaille; 4–5 Argelander; 5 m. Heis ($o_2 = 3$–4); 4–5 Behrmann ($o^2 = 4{\cdot}0$); 4·36 Sir J. Herschel ($o^2 = 3{\cdot}75$); Sir W. Herschel gives 22, 16 (o^1), 28; 5 *Cape Catalogue* (1878·11). It is No. 157 of *Birmingham's Catalogue.* Schmidt called it "very red," and Gould "orange-red." The difference between the magnitudes of o^1 and o^2 as given by Sir J. Herschel is 0·61, by Heis 1·66, and by Behrmann only 0·33, a considerable discrepancy. The Cordoba estimates of magnitude vary from 3·8 to 4·2; Franks 5 m. December 31, 1877; on March 4, 1883, I found $o^1 = \xi^1$, and at least one magnitude fainter than o^2 (3·4 Gould). 4·04 H.P.

No. 202. π^3 (19) Canis Majoris.—5 m. Lalande (13452); 6–5 Argelander and Heis; 5·5 Johnson (1854); 4·9 at Cordoba. Dr. Gould says, "It seems evident that the brightness of this star has increased" (*U. A.*, p. 305). In January, 1876, I found it slightly brighter than π^1 (15). 4·45 H.P.

No. 203. ϵ Canis Majoris.—3 m. Sufi, Lacaille and Harding; 2·1 Argelander and Heis; 1·86 Sir J. Herschel (mean of 16 estimates, *Cape Observations*, p. 344); 1·8 Gould; 3 m. *Cape Catalogue* (1875·12). Its low meridian altitude in the sky of central Europe may account for its being underrated by Harding, but it is not so easy to understand why it should have been rated only 3 m. by Lacaille, who observed it at the Cape of Good Hope. 1·49 and 1·7 H.P.

In January, 1876 (Punjab), I found it certainly 2 m., but not much brighter than δ.

No. 203a. Lalande 13627 Monocerotis.—6 m. Lalande and Harding; 6 Heis; 5·6 Gould; 5·8 Franks, March 25, 1884. Suspected variable by me, February 17, 1884, when I found it only 6·1 m.; numerous observations in February and March, 1884, vary from 5·5 to 6·1.

No. 204. σ (22) Canis Majoris.—A red star; suspected variable by Gould; he calls it "excessively red." It was rated 4 m. by Lacaille, Harding and Heis; once 5 m. by Argelander; 4-5 Behrmann; 5-4 Schmidt ("very red"); 3·92 Sir J. Herschel (*Cape Obs.*, p. 347). The Cordoba estimates vary from 3·5 to 4·2. In February, 1875, I estimated it 4½ m.; January 22, 1876, very slightly brighter than o^1 (5 m. Heis); February 3, 1883, about two steps brighter than o^1. Both stars red. 3·49 H.P.

No. 205. 19 Monocerotis.—5 m. Lalande (13658); 5 m. Harding; 6 m. Argelander; 6-5 Heis. The Cordoba estimates vary from 5·4 to 5·8; 6 m. Franks, December 31, 1877; 5-6 *Cape Catalogue* (1879·11). About 8′ *f* is the star 2307 B A C (= LL 13678), which has also been suspected of variation (*Memoirs R.A.S.*, vol. xxi.) It is 8½ m. in *Lalande's Catalogue;* 8 m. Harding and Piazzi. With reference to this star Gould says:—"The supposition of variability may have arisen

from mistaking it for F 19." Franks rated it 7·0, March 25, 1884, (*private letter*). It was estimated 8 m. at Cordoba. February 17 1884, I estimated 19 5·6 m.; February 21, 5·5 m.; March 3, 5·5; March 7, 5·6; March 11, 5·5; March 14, 5·3 m.; March 20, 5·4; March 21, 5·3; March 31, 5·5; April 1, 5·3.

No. 206. 2306 B.A.C. MONOCEROTIS.—6 m. Lalande (13648). Not in *Heis's Catalogue*; 5·5 m. Franks (1878), "and nearly = 38 Geminorum." Harding has a 6 m. near the place, but some minutes north of Lalande's position. March 23, 1884, I estimated it 5·8 m., brighter than 16, but five steps less than 17 Monocerotis.

No. 207. γ CANIS MAJORIS.—One of Pigott's suspected variables. He says (*Phil. Trans.*, 1786), "Maraldi could not see this star in 1670, but in 1692 and 1693 it appeared of the fourth magnitude. I have very frequently noticed it since 1782, but perceived not the least variation, being constantly of the fourth magnitude, very little brighter than θ and decidedly brighter than ι." Sir J. Herschel remarks (*Cape Obs.*, p. 315, Sequence, November 12, 1836), "γ Canis at 3h. 20m. A M was of fifth magnitude. Bode sets it down as variable." It was rated 4-5 by Heis, and 4·5 at Cordoba; 4½ Franks (= ι) December 31, 1877. 4·10 H.P.

In January, 1876, I found γ a little brighter than ι; February, 1877, γ nearly half a magnitude brighter than ι.

No. 208. δ CANIS MAJORIS.—3 m. Sufi; 2 m. Lacaille; 3 Harding; 2 m. Argelander and Heis. Sir W. Herschel gives 2 (β) , δ , 31 (η); 2·32 Sir J. Herschel (mean of 15 estimates, *Cape Obs.*, p. 343). Smyth (*Bedford Catalogue*) assumes 3½ m. as correct (!), the same as Piazzi's estimate. It was rated 2·1 at Cordoba. In January, 1876 (Punjaub) it seemed to me rather less than 2 m. but certainly brighter than 3 m.

No. 209. τ GEMINORUM.—5 m. Lalande, and Harding; 5-4 Heis; 4·3 in Pierce's reductions of Sir W. Herschel's estimates (*Harvard Annals*, vol. ix., p. 69); 4·71 Pritchard, 1882·305. Sir W. Herschel gives 60 (ι)–46 (τ) and 69 (υ) , 46 (τ). 4·63 H.P.

October 6, 1883, τ five steps less than ι.

November 20, 1883, I found τ one step less than υ, and four steps less than ι.

No. 210. BIRMINGHAM 169 LYNCIS.—6 m. Harding; 7·7 Argelander; 7 m. Struve ("rubra"). Birmingham found it "blue or bluish white," January 13, 1874, and says, "The star is probably variable in colour, if not in magnitude." It is 44 Camelopardali of Flamsteed.

No. 211. LALANDE 14088 CANIS MAJORIS.—9 m. Harding; 6 m. Hencke and Argelander. Not in *Piazzi's Catalogue*, nor in Heis or Behrmann; 6·8 Gould. From the difference in the estimates of

magnitude by Harding and Hencke, I suspected this star of variation. January 22, 1877, when I found it reddish, and nearly half a magnitude brighter than Lalande 14105, which lies closely south of it; January 31, 1878, a little *less* than LL 14105; February 25, 1880, one step brighter than LL 14105; January 30, 1883, one step less than LL 14105; March 3, 1883, two steps less than LL 14105; February 22, 1884, two steps less than LL 14105. This star seems certainly variable to a small extent. Gould gives LL 14105 as 6·9.

No. 212. 18 Heis Lyncis = Lalande 14028 (5 m.)—5·8 Argelander, 5·2 in *D M*; 6-7 Heis; 5·01 Pierce, who says (*Harvard Annals*, vol. ix.), "Heis makes this star 6·3, and I, 5·0. Argelander makes it equal to 26 *Lyncis*; Heis makes it 0·5 fainter; the D M., 0·2 brighter; and I, 0·4 brighter. Argelander makes it equal to 16 Heis Lyncis; Heis makes it 0·5 fainter; the D M., 0·3 brighter; and I, 0·5 brighter. April 8, 1876, it seems not to have changed since my measures." 4·77 and 4·9 H.P.

No. 213. 27 Canis Majoris.—5½ m. Lacaille; 4 Harding; 5 m. Argelander; 6-5 Heis; 6 m. Behrmann; 5·4 Gould. Sir W. Herschel found 28-27, 26. In 1874, 1875, and 1876, I found it about 5½ m., and much inferior to 28; February, 1877, slightly brighter than 29. 4·54 H.P.

No. 214. Lalande 14123 Canis Majoris.—7 m. Lalande; not given by Piazzi. In January, 1877, I found this star only 9 m.

No. 215. γ^2 Volantis.—See *Uranometria Argentina*, pp. 248, 249.

No. 216. Struve 1058 Canis Minoris.—A double star 8½, 11: 281°: 22″·32, Burnham, who measured it in 1879 and 1881, but failed to see the companion in 1874–5 and 1878; Dembowski could not find it in 1865.

No. 217. λ Geminorum.—3 m. Ptolemy; 3-4 Sufi; 3 m. Ulugh Beigh; 4 m. Tycho Brahé and Hevelius; 5 and 4 Lalande; 4-3 Argelander; 4 m. Heis (δ = 3-4 Argelander and Heis). Sir W. Herschel found 54 (λ); 55 (δ), and says, "54 seems to be increasing. There is an interval of 9 months between the two observations of my catalogue. Mr. Bode supposes the star to be changeable. See *Astronomische Jahrbuch*, 1788, p. 255, and 1793, p. 201" (*Phil. Trans.*, 1796, p. 480); 3·72 Pritchard (1882·305). 3·58 H.P.

Franks found $\lambda = \delta$, both 4 m., January 28, 1878.

January 18, 1876, I found λ almost exactly equal to δ (both small 3 m.).

October 6, 1883, $\lambda = \delta$.

No. 218. 30 CANIS MAJORIS.—5 m. Lacaille; 6 m. Harding; 5-4 Heis; 5 m. Behrmann; 4·6 at Cordoba. Sir. W. Herschel gives 28–30·29. Gould calls it τ Canis Majoris. 4–5 *Cape Catalogue* (1878·10). 4·31 H.P.

February 3, 1877, 30 about equal to 28, and about half a magnitude brighter than 29.

No. 219. 65 AURIGÆ.—6 m. Lalande (14218), and Harding; 6-5 Heis; 6 m. Franks (1878). On January 31, 1884, I found it one step less than 63 Aurigæ, but three steps brighter than 64. Heis gives 63 5 m., but it seems to be now nearer 6 m. 6·5 is 5·34 and 5·1 in H.P.

No. 219*a*. LACAILLE 2761 PUPPIS.—6 m. Lacaille. Dr. Gould says this star "is below 8½, being indeed little, if any, above 8¾. It is almost incredible that Lacaille should have been able to descry so faint an object with his little telescope" (*U. Argentina*, p. 283). It is 7 m. in the *Cape Catalogue* (1880), and Stone says, "This star appears to be a variable."

No. 220. ι GEMINORUM.—4½ and 4 Lalande; 4 Harding; 4 m. Heis; 3·98 Pritchard (1882·305); 4 m. Franks, January 28, 1878. Sir W. Herschel gives 60 (ι) – 65 (b^2), and 60 – 46 (τ), and 60, 62. October 6, 1883, I found ι five steps brighter than τ; November 20, 1883, ι four steps brighter than τ. 4·03 and 4·4 H.P.

No. 221. 61 GEMINORUM.—7 m. Lalande (14426); 7 m. Harding; 6 m. d'Agelet, October, 1784; 7-8 Piazzi (ten times); 6·7 Taylor (1834-35); 6 m. Argelander and Heis; 6·5 in the *Durchmusterung*, and 6·3 in the Radcliffe observations, 1870 (*Nature*, May 13, 1875). Sir W. Herschel gives 26, 61 and 63, 61. October 6, 1883, I found it much fainter than 63, and about 6·7 m.; November 20, 1883, much fainter than 63, and about 6½; February 21, 1884, about 6·3 m., one step brighter than 58, but considerably less than 56 and 63.

No. 222. β CANIS MINORIS.—3 and 4½ Lalande; 3 m. Heis; 3·41 Sir J. Herschel (*Cape Obs.*, p. 342); 3 m. Gould; 3½ Franks, January 28, 1878; 3·11 Pritchard (1883·215). In March, 1876, I found β very slightly brighter than ϵ Geminorum. β is 3·07 and 3·5 H.P.

No. 223. ♅ IV. 45 GEMINORUM.—A "nebulous star," with a distant companion, 7½, 8 : 2°·4 : 100″. Chambers says, "Knott reverses the magnitudes of A and B. Fletcher asserted confidently that A is variable. In April, 1865, he saw it no brighter than a 10th mag. star."

No. 224. LALANDE 14551 PUPPIS = P VII. 116 = Σ 1097.—6 m. Lalande; 6·3 Gould. Found to be variable by Espin, while using it as a comparison star for U Monocerotis in 1883. His photometric

measures in February, March, and April, 1883, vary from 6·09 to 6·77. It is a quintuple star, Struve's principle star having been found closely double by Burnham, with two other faint companions, within 31″ of the primary. 5·77 H.P.

No. 225. 65 (b^2) GEMINORUM.—Rated 8½ m. by Lalande in March, 1794, and 5½ m. in February, 1795; 5-6 Piazzi; 7 m. Bessel; 5 m. Heis. Sir W. Herschel found 60-65·64. My observations are:—

January 18, 1876, 65 about = 64, or perhaps slightly less.
December 30, 1876, 65 very slightly brighter than 64.
January 28, 1878, 65 about = 64.
December 1, 1880, 65 and 64 exactly equal.
December 25, 1881, 65 two steps brighter than 64.
January 7, 1882, 65 two steps brighter than 64.
March 31, 1883, 65 two steps brighter than 64.
November 20, 1883, 65 one step brighter than 64.

No. 226. WB. 669 MONOCEROTIS.—Observed as 4½ m. by Rumker in 1822, and suspected by Olbers, in 1824, to be a remarkable variable. It was rated only 8·9 by Fellocker in the Berlin Academy Charts. It is not given in *Argelander's Uranometria*, but is 6·5 in the D.M. Heis rated it 6-7, and identified it with VII. 669 of *Weisse's Second Catalogue*. It is 6·0 in the *Uranometria Argentina*. It is not in *Lalande's Catalogue*, but is 7 m. in *Harding's Atlas*, and underlined. March 27, 1875, I found it about 7 m.; January 19, 1876, and January, 1877, about 6½ m., less than 25 Monocerotis, but brighter than two stars *f*; March 18, 1877 (Punjab), visible to naked eye, about 6 m., but less than 25 Monocerotis; January 31, 1878, less than 25, but brighter than the two stars *f*; March 31, 1883, from comparisons with 25 and 24, I estimated its mag. 6·2; February 21, 1884, I estimated it 6·1 – about = LL 15136.

No. 227. BIRMINGHAM 178 MONOCEROTIS = LALANDE 14599.—6 m. Lalande; 7m. Birmingham, February 14, 1875; 6·3 Tebbutt, June, 1875; 6·2 at Cordoba. In February, 1876, and January, 1877, I estimated it at 6½ m. (*Southern Stellar Objects*, p. 98). Photometric measures by Espin in February, March, and April, 1883, vary from 6·35 to 6·57 (*private letter*).

No. 228. LALANDE 14571 GEMINORUM.—8½ Lalande. Suspected variable by Tebbutt, 1880 (*Mon. Not. R.A.S.*, May, 1880). On December 1, 1880, January 7, 1882, and March 31, 1883, I found it two steps less than BAC 2472 (closely *n p*).

No. 229. – CANIS MINORIS.—6 m. in *Harding's Atlas*, but observed only 7½ m. by me, February 4, 1877. It was then less than Lalande 14720, but brighter than Lalande 14726. It seems to have been

observed as 8 m. by Bessel (*Weisse*, vii. 780), and it is 8·1 in the *Durchmusterung* (*Nature*, March 29, 1877). It is not in the *Washington Catalogue*. (1845-1871), nor in the *Armagh Catalogue*.

No. 230. δ^2 CANIS MINORIS.—Not in *Lalande's Catalogue;* 6 m. Harding and Heis; 6·2 Gould; 6 m. Franks, January 23, 1878. Sir W. Herschel, 9·8. In March, 1876, I found it less than δ^1, but slightly brighter than δ^3; November 22, 1883, δ^2 four steps less than δ^1, but one step brighter than δ^3; March 21, 1884, δ^2 estimated 6·2, three steps less than δ^1. 5·63 and 5·9 H.P.

No. 231. 9 CANIS MINORIS.—Not in *Lalande's Catalogue;* 6 m. Harding (δ^3); 6-7 Heis. Not in Argelander's *Uranometria;* 6·4 at Cordola; 6 m. Franks, January 23, 1878. November 22, 1883, I found it one step less than δ^2; March 21, 1884, two steps less than δ^2.

No. 232. LACAILLE 2858 PUPPIS.—6½ Lacaille. The Cordola estimates vary from 6·8 to 6·4. Gilliss seems to have failed to see this star in 1851 (*Uranometria Argentina*, p. 280).

No. 233. LACAILLE 2893 PUPPIS.—7 m. Lacaille. The Cordoba estimates vary from 6·7 to 7·5.

No. 234. U CANIS MINORIS.—A red star, discovered by Baxendell, November, 1879. It is not in *Lalande's Catalogue*, nor in *Harding's Atlas*. It is not in *Birmingham's Catalogue of Red Stars*. It was examined with the spectroscope at Lord Lindsay's observatory, but "showed no peculiarity, and no particular colour seemed to predominate in its spectrum." To the eye the colour was a "faint red or purple." Observations from November 27 to December 8, 1879, indicated a decrease of half a magnitude. On December 10 it was about 8·9 m. of Argelander's scale; on January 4, 1880, I found it fainter than Lalande 14895 (8½ m.). The position given in the catalogue is only approximate.

No. 235. LALANDE 14970 CANIS MINORIS.—6½ m. Lalande; 7 m. Bessel and Santini. It was rated 6–7 m. by Heis, but is not in Argelander's *Uranometria*. The Cordoba estimates vary from 6·3 to 7·4. From observations, 1881–1883, Espin found that the star slowly increased in light, and probably belongs to a class of variables having a "small variation in magnitude and a period of several years" (like 63 Cygni). April 8, 1882, I found this star brighter than LL 14950 and LL 15027; March 17, I estimated it 6·3; March 21, 6·4; March 31, 6·4.

No. 236. 16 HEIS ARGO NAVIS = OA 7239.—6 m. Heis. Not in *Behrmann's Catalogue*. Found below 7 m. at Cordoba. It is 6 m. in *Harding's Atlas*, and may possibly be variable.

No. 237. 76 (*c*) Geminorum.—6 m. Lalande (14991); 6 m. Heis; 6 m. Franks, 1878. Sir W. Herschel found $\phi - 76$. 5·33 and 5·8 H.P.

November 24, 1878, I found 76 less than v; also less than ϕ.

December 1, 1880, same relative magnitude.

January 12, 1882, 76 about three steps less than a 6 m. star (Heis) *n. f* ϕ, or about mag. 6·3.

November 22, 1883, 76 nearly one magnitude less than ϕ, but brighter than any star in the immediate vicinity of ϕ.

No. 238. κ Geminorum.—Comes possibly variable from 8·5 to 14 (Webb, *Cel. Objects*, p. 310). Herschel called attention to the companion of this star as probably shining by reflected light from the primary. Dembowski thought it variable.

No. 239. β Geminorum (Pollux).—Admiral Smyth measured two distant companions to this star as follows:—

$$\left.\begin{array}{llll} \text{Position AB} & 66^\circ\cdot 9. & \text{Distance} & 130''\cdot 0 \\ \quad ,, \quad \text{AC} & 73^\circ\cdot 6. & \quad ,, & 202''\cdot 7 \end{array}\right\} \text{Epoch } 1832\cdot 31,$$

and says (*Bedford Catalogue*, p. 187) A 2, orange tinge; B 12½, ash-coloured; C 11½, pale violet, and it has a minute *comes* to the *s p*, which, though unnoticed in former registers, is certainly now (1832) as bright as C: these companions form a neat triangle," and he adds in a foot note: "While this is in the press the Rev. W. R. Dawes has shown me an exact diagram which he made of the object January 1, 1829, with a 3½ foot achromatic, charged with a Huygenian eyepiece magnifying 200 times. With this instrument he saw the three companions very distinctly, although two only were visible, and that but on remarkably fine nights, in Sir James South's 7-foot equatorial, with an aperture of 5 inches."

In the *R. A. S. Monthly Notices* for April, 1861, the Rev. T. W. Webb remarks that with his 5½ inch OG, the third star appears "as much inferior to B, 12 m, as B is below C; and as Sir James South's equatorial of 5 inches had shown but two companions some years before the date of the *Bedford Catalogue*, there is perhaps grounds to suspect a variation in its light."

Burnham, 1879·24 rated Smyth's star C as 9 m. and the third star 9·5 m. In 1878 he called B 10 m.

My own observations are as follows:—

January 30, 1880, 3-inch refractor, power 133. C quite plain, and B tolerably so, with Pollux in the field. D (Smyth's third star) only seen with Pollux just out of the field. C about one magnitude brighter than B, and B 1½ or 2 magnitudes brighter than D. D very faint. To my eye C seems about 10 m. (Smyth's scale) B = 11 m. and D 12½ m.

March 31, 1881, 133 on 3-inch refractor. C brighter than B. D very faint, hardly visible. D not seen with power 83. 9.30 p.m. moon just set, and sky rather bright.

If D was ever equal to C, as expressly stated by Smyth, it must certainly be variable.

Pollux itself has often been suspected of variation, as some of the early observers have rated it below Castor, while at the present time Pollux is decidedly the brighter by about half a magnitude. Sufi (tenth century) rated both stars as 2 m.

No. 240. LACAILLE 2932 PUPPIS = 1 Flamsteed.—6 m. Lacaille; 5m. Argelander; 6 m. Heis; 5 m. Behrmann. The Cordoba estimates vary from 4·8 to 5·6. In March, 1876, I found this star equal to *p* Puppis (Lacaille 2867, 5·3 m. Gould).

No. 241 π (11) CANIS MINORIS.—Not in *Lalande's Catalogue.* Sir W. Herschel 6 , 11 , 1; 5·0 in *Durchmusterung;* 5·3 and 5·6 Gould; 5½ Franks (> 1) January 28, 1878; 6 m. Harding; 6–5 Heis. 5·46 H.P.

In March, 1876, I found it about one magnitude brighter than 1 Canis Minoris, and almost exactly equal to 6 (5 m. Heis; 5·0 Gould). February, 1877, a little less than 6 Canis Minoris; November 22, 1883, four steps less than 6, or 5·4 m.; March 22, 1884, 5·4 m., three steps less than γ Can. Min.

No. 242. STRUVE 1143 CANIS MINORIS.—A double star, 152°; 9″·34 measured by Struve (1825·21), but never afterwards seen. Burnham carefully searched for it 1874-5, with 6-inch refractor, and in 1881 with 18½-inch, but without success, and he thinks there must have been some error in Struve's place.

No. 243. No. 36 of the "Addenda" to *Birmingham's Catalogue.*— = Arg. + 33° , 1601 (6·5); 6½ Lalande (15200); 6 m. Burton, with small *comes*; 7·5 m. Birmingham, March 4, 1877. He says, "Probably variable in colour and magnitude." It was rated 6-7 by Heis (No. 98 of Gemini).

February 21, 1884, I estimated it 6·1, two steps less than 70 Geminorum, but three steps brighter than 86 Heis Geminorum.

No. 244. ζ CANIS MINORIS.—5 and 6 m. Lalande; Sir W. Herschel gives ζ – 14; 6 m. Argelander; 5-6 Heis; 5 m. Houzeau (1875·18); 5·7 Gould; 5 m. Franks (January 23, 1878). In March, 1876, I found it a little less than the star Lalande 15695–6.

November 22, 1883, ζ 4 steps brighter than Canis Minoris; March 21, 1884, estimated 5·5; March 31, 5·5. 4·99 and 5·3 H.P.

No. 245. BIRMINGHAM 192, CAMELOPARDI.—Not seen by Birmingham, 1873; "slight red tinge," January 13, 1874; not seen January 21, 1876. Birmingham says, "Knott failed to see it, June 25 and August 3, 1866. Possibly *variable.*"

No. 246. ϕ Geminorum.—5 and 6 m. Lalande; 5 m. Harding and Heis. Sir W. Herschel gives $\phi - 76$; 5 m. Franks, January 28, 1878 (*private letter*). November 22, 1883, I found it one step less than 6 Cancri.

No. 247. Lalande 15374–5 Monocerotis.—6 m. Lalande and Harding; 6 m. Heis; 7½ Piazzi. The Cordoba estimates vary from 6·0 to 6·6. On February 21, 1884, I estimated it 6 m., one step brighter than LL 15136; March 15, 1884, 6·0 m.; April 1, 1884, 6·0. 5·68 H.P.

No. 248. – Geminorum.—Included by Schönfeld in his provisional list. He says, "Winnecke's Stern d zu U Geminorum, A N 47·1120; schwankt einige Stufen um die Grösse 11·2 m., auch meinen Beobachtungen."

No. 249. Lacaille 3081 Puppis.—6 m. Lacaille; 6–5 Heis and Behrmann. The Cordoba estimates "vary systematically from 5·2 to 5·8." 4·81 H.P.

No. 250. Anon Argûs.—Position only approximate.

No. 251. 2695 B.A.C. Argûs.—6 m. in the *Paramatta Catalogue*, but twice recorded by Taylor as 10 m. It was missed in August, 1874, by Tebbutt at Windsor, N.S.W., "being then invisible in a telescope of 4½ inches aperture." The star is not in *Lacaille's Catalogue*. It was searched for at Cordoba, but without success. In the same field of view is the star B.A.C., 2694, which Tebbutt found "decidedly red." It seems to be identical with Lacaille 3140 (6½) (*Nature*, April 15, 1875) which was rated 5·5 at Cordoba ("red").

No. 252. 8 Cancri.—6 m. Lalande; 7 m. Bessel; 5·8 in DM; 6m. Argelander and Heis; 5·6 Gould at Albany, and 5·4 at Cordoba. Suspected variable by Gould, although he includes it among his Standards of Magnitudes (*Uranometria Argentina*, p. 26); 6-7 Houzeau; 5 Franks, January, 1878. On February 8, 1880, I estimated it 5½ m., and equal to 68 Geminorum. 5·13 and 5·3 H.P.

No. 252. 14 Puppis.—6½ m. Lalande (15837); 6 Harding; 6-7 Heis; not in *Argelander's Uranometria*; 6·7 Gould; 6-7 *Cape Catalogue* (1880).

No. 254. ι (15) Argûs.—3½ Lalande (ρ); 4 Harding; 3 Heis (ι); 3·2 Gould; Schmidt suspected variation; 3-4 *Cape Catalogae* (1874·87). In March, 1876, I found this star about half a magnitude brighter than ξ Puppis. ι is 2·88 in H.P.

No. 255. 29 Monocerotis.—A triple star, 5·5, 13, 9 : 104°·7, 243°·8 : 30″, 66″·9; 13 was not seen by Herschel and South; Sadler rated it 10 m. in 1875, and Franks 11 m. in 1877. I saw it with a 3-inch refractor in 1874, in India; 29 was rated 5-4 by Heis, 4·9 by Gould, 5·32 by Pritchard, and 4·47 H.P.

No. 256. - CANCRI.—See *Astronomische Nachrichten*, No. 2434.

No. 257. ψ^2 CANCRI.—6 m. Lalande; Sir W. Herschel gives ψ^2, ω^1 and 6 (χ) - 14 (ψ^2), 11; 6 m. Argelander; 6-5 Heis; 6 m. Houzeau (1875·24), who says, "L'étoile ψ_2 Cancri, estimeé par Lalande de la 4me. grandeur, dans la Conaissance des temps de 1810, figure seulement dans mes observations comme un astre du 6 me. ordre." Franks estimated it 6 m. January 31, 1878, and says, "Certainly variable—fine pale yellow." 5·78 H.P.

I found the star 6 m., April 7, 1875; April 1, 1884, I estimated it 5·9.

No. 258. STRUVE 1198 HYDRÆ.—A double star, 8, 8·2: 157°·5: 33″. Struve suspected the components of variation (*Celestial Objects*, p. 325). It seems to be Lalande 16011–12, rated 9½ and 9 m.

No. 259. LACAILLE 3197 PUPPIS.—6 m. Lacaille; 5-6 Behrmann; Gould says, "I suspect this star of variability between the approximate limits $5{\cdot}1^m$ and $5{\cdot}8^m$."

No. 260. LACAILLE 3236 VELORUM.—6·0 m. Gould ("red"); 5-6 *Cape Catalogue* (1880). Stone says, "This star may be variable. Lacaille calls it a 7 magnitude star."

No. 261. 30 MONOCEROTIS = C HYDRÆ (Gould).—3 m. Ptolemy and Sufi; 4 m. Lalande (16559-60); 4-3 m. Argelander and Heis; 4-5 Houzeau (1875·18); 3·8 Gould; 5 m. Franks, January 30, 1878; 3·63 Pritchard (1882·971). This star is placed in Hydra in *Lalande's Catalogue*, and is called C Hydræ in the *Uranometria Argentina*. It is 4-5 m. in the *Cape Catalogue* (1879·09).

March 4, 1884, I estimated it 3·9, three steps less than δ Hydræ; April 1, 3·8.

No. 262. LALANDE 16615 PUPPIS.—5½ m. Lalande. Gould says it "appears to vary from 5½ m. to below 6 m., yet its colour may have influenced the estimates to some extent." 5·76 H.P.

No. 263. β VOLANTIS.—4 m. and 5 m. Lalande; 4·57 Sir J. Herschel; 6 m. Gilliss; 4-5 Behrmann; 4·2 Ellery (1869). The Cordoba estimates vary from 3·6 to 4·4 (*U.A.*, p. 249).

No. 264. LACAILLE 3344 (ARGO).—7 m. Lacaille; not in *Harding's Atlas*; 6 m. Behrmann (1 Mali); not in *Heis's Catalogue*. The Cordoba estimates fluctuate from 6·9 to 7·7; and Gould says, "The star is probably variable between the limits 6^m and 8^m." 7 m. in *Cape Catalogue* (1878·23). 6·36 H.P.

No. 265. θ CANCRI.—A star with a distant companion, 5½, 9 : 59°·5 60″·7 (1880). According to Chambers, Knott suggests variation, as he found the companion only 12 m., whereas Sir J. Herschel and Smyth agreed in calling it 9.

No. 266. – MONOCEROTIS.—Observed as 9 m. by Dreyer, March 8, 1879. It is not in the *Durchmusterung*, nor in *Bond's Zones* 46 and 47, but appears as an 11 m. in Zone 48. As the *Harvard Zones* contain stars to 11 m. of Argelander's scale, Dreyer considers this star may be variable. It also occurs as a 10 m. in the *Munich Catalogue of Stars*, between + 3° and – 3° declination. Dreyer gives its position as $16^s\cdot 7$ *p* and 103″ *north* of Schjellerup's red star 109 (= 203 of *Birmingham's Catalogue* = LL 16770) (*Mon. Not. R.A.S.*, April, 1879).

No. 267. LACAILLE 3499 VOLANTIS.—(*Uranometria Argentina*, p. 140).

No. 268. OELTZEN 515 CAMELOPARDI.—Position given in the Catalogue is only approximate. The place for 1855 is R A $8^h\ 21^m\ 43^s$, declination + 83° 13′·2.

No. 269. ζ PYXIDIS = *f* MALI = LACAILLE 3450., 5 m. Lacaille; 6-5 Heis and Behrmann. The Cordoba estimates show signs of variation from 5½ to 5¾, or lower (*Uranometria Argentina*, p. 297). It is a red star.

No. 270. ι CANCRI.—4 m. Sufi; 5 m. Lalande and Harding; 4 m. Heis; 4 m. Franks, "pale orange;" 4·24 Pritchard (1883·019). It is a double star, 5·5, 8, 1836 (Dembowski, 4, 6·5, vars. 1858), 307°·8 : 30″ (*Cel. Obj.*, p. 253). In January, 1876, I found ι brighter than γ, and about equal to δ Cancri. 4·16 and 4·3 H.P.

No. 271. 52 CANCRI.—6 m. Lalande (17421); 7 m. Harding; 7 m. *Armagh Catalogue*; 8·5 m. *Washington Catalogue*. Not in *Heis*. Sir W. Herschel found 52 brighter than 68 and 71 Cancri, and nearly = 80 and 54 – 52.

My observations are:—February 28, 1878, 8 m., less than Lalande 17384; December 23, 1878, 8 m.; February 8, 1880, 8 m.; November 22, 1883, 8 m.

My observations, compared with those of Sir W. Herschel, seem to prove variation in the light of this star.

No. 272. 15 HYDRÆ.—6 m. Lalande (17490); 6 m. Heis; 6 m. Franks, January 30, 1878. Gould says, "The brightness of this star appears to have varied between the magnitudes 5·7 and 6·3 more than once during the period of our observations." March 4, 1884, I estimated it 6·0; April 1, 5·9.

No. 273. R PYXIDIS.—Variable according to Gould. The Cordoba estimates fluctuate between 6½ and 7·4. The star is not in *Lalande's Catalogue*.

No. 274. Birmingham 211 Cancri.—6½ Lalande (17576); 6 m. Chacornac; 7 to 7·5 Birmingham; 8 m. Webb, March 6, 1872 My observations are: —

February 28, 1878, 7·3 m. slightly brighter than 2 stars *n p*.
December 21, 1878, 7½ m., and equal to the 2 stars *n p*.
November 22, 1883, 7½ m., and equal to the 2 stars *n p*.

No. 275 60 (a^1) Cancri.—5 m. Lalande and Harding; 6 m. Heis; 8 m. Webb; 8 m. Birmingham; 6 m. Franks, January 30, 1878.

Sir W. Herschel gives 45·60 , 50.
February, 1877, I found 60 equal to 45 Cancri.
February 28, 1878, same brightness.
November 22, 1883, 60 two steps less than 45.

No. 276. *w* Velorum = Lacaille 3638.—Gould says, "There is some ground for supposing *w Velorum* to fluctuate between $5^m\,0$ and $5^m\,5''$. 5-6 m. *Cape Catalogue*, 1880.

No. 277. σ^2 Ursæ Majoris.—5 m. Heis. A double star, 5·5, 9·5: 244°·8 : 2″·7, 1876. Sadler thinks the *comes* almost certainly variable, 5·5 probably so (*Cel. Obj.*, p. 404).

No. 278. κ Cancri.—4-5 Sufi; 4½ Lalande; 7 m. Bessel; 5·5 DM; 5 m. Argelander and Heis; 5·6 Gould (at Albany), and 5·4 at Cordoba. Suspected variable by Gould, although he includes it among his "Standards of Magnitudes" (*U. Argentina*, p. 26). Sir W. Herschel gives 47 (δ) - - 76 (κ) , 45. January, 1876, I estimated it between 5 and 5½ m.; November 22, 1883, κ three steps brighter than 45. 5·03 H.P.

No. 279. κ Pyxidis = Lacaille 3685 (Argo) = 3121 BAC.—6 m. Lacaille; 5 m. Heis; 6-5 Behrmann; 4, 4·5 and 5 m. Argelander. It is No. 217 of *Birmingham's Catalogue*. Gould suspects variation, as the Cordoba estimates vary from 4·3 to 5·1. He says, "Its colour is a bright orange." 6 m. *Cape Catalogue* (1878·13.)

No. 280. Lalande 18044 - 5 Cancri = BD 31°, 1946.—5½, 6 Lalande; 6·5 DM; 6 m. Birmingham, 1872; 7·1 Copeland, February 19, 1876; 7 m. d'Arrest, who finds a spectrum similar to a Herculis and β Persei, and considers that a slight variability of the star is probable (*A.N.* 2032). It is No. 218 of *Birmingham's Catalogue of Red Stars*. 6·50 H.P.

No. 281 π^1 (81) Cancri—7½ m. Lalande; 6 Harding; 6–7 Heis. Sir W. Herschel gives 54 , 81 81–68 and 81 , 83. February, 1877, I found it more than a magnitude less than π^2 (6m. Heis), or about 7m. November 22, 1883, π^1 about 7 m., and one step less than 54.

No. 282. Lacaille 3731 Velorum.—7 m. Lacaille; 6 Behrmann. The Cordoba estimates vary from 6·3 to 7·1, and Gould says, "It is not improbably variable."

No. 283. Lacaille 3744 Velorum.—7 m. Lacaille; 6 m. Brisbane and Behrmann. The Cordoba estimates vary from 6·2 to 6·8.

No. 284. 3180 B.A.C. Argûs.—Rated 6 m. by Argelander and Heis; but found only 8 or 8½ m. at Cordoba (*U. A.* pp. 297–8).

No. 285. 26 Hydræ.—6 m. Argelander; 6–5 Heis; 5m. (M_2) Houzeau (1875·20); 5·3 Gould; 5 m. Franks, "bright yellow, superior to κ, March 2, 1878." (Heis rated κ, 5 m). In February, 1877, and April 21, 1878, I found 26=27 Hydræ. It is 5–6 m. in the *Cape Catalogue* (1879·16). 4·90 H.P.

No. 286. Lacaille 3833 Pyxidis.—6½ Lacaille; 6 m. Harding, Brisbane, and Behrmann. The Cordoba estimates fluctuate between 6·1 and 6·7. It is 6–7 m. in the *Cape Catalogue* (1878·27).

No. 287. α Hydræ.—2 m. Ptolemy, Sufi, Argelander, and Heis. 2·30 Sir J. Herschel (mean of 15 estimates, varying from 1·75 to 2·58; 2·1 Gould. Franks considered it nearer 3 m. than 2½, March 2, 1878 (*private letter*). Sufi calls it red. In the *Chinese Annals* it is called the "Red Bird." Birmingham calls it "pale yellowish red." Gemmill observed it to be remarkably bright on May 9, 1883, when he thought it nearly equal to Pollux. He also observed it very bright February 20, 1882, and the red colour very conspicuous. Sir J. Herschel suspected variations, and says (*Cape Obs.*, p. 349), "At the time I regarded the observations as satisfactory, and the result as sufficiently established; but the occurrence of a similar phenomenon, with a period nearly identical in the case of α Cassiopeiæ, the period in both cases being nearly a lunation, inclines me to distrust both conclusions, and to believe that the colour of the stars (in both cases verging to redness) has affected the judgment in the presence of moonlight differently from that of the stars of comparison." Schmidt holds the same opinion; and Dr. Gould remarks, "I suspect that the supposed variability of α Hydræ may be attributed to the influence of its ruddy colour upon the estimates of its brilliancy."

No. 288. ξ Leonis.—6 m. Sufi, Ulugh Beigh, and Argelander; 4 m. Tycho Brahé and Hevelius; 5 m. Harding; 5–6 Heis; 5·6 Gould (at Albany, and 5·4 at Cordoba. Sir W. Herschel gives 10 , 5 (ξ)–6. The star is marked as 4 m. and "variable" in *Dien's Atlas*.

No. 289. 3245 B.A.C. Ursæ Majoris = Piazzi 91.—8 m. in *Harding's Atlas*. In the notes to the BAC Baily says, "Taylor considers the magnitude of this star to be variable." It lies closely *s f* 22 (Fl.) U. Majoris. April 2, 1884, I estimated it 8 m., slighly brighter than a small star *s f*.

No. 290. N. Velorum = Lacaille 3910.—3½ m. Lacaille; 4–3 Behrmann. Dr. Gould considers it variable from 3·4 to 4·4, with a period of about 4½ days; he also suspects variation in colour (*Uranometria Argentina*, p. 276).

No. 291. 10 LEONIS (= 1 Heis Sextantis = LL 18893).—5 m. Lalande; 6 m. Heis; 5·8 D.M. Sir W. Herschel gives 10, 5 (ξ); 5·4 Gould, who suspects variation, although included by him in his "Standards of Magnitude" (*U. A.* p. 27); February 22, 1884, I estimated it 5·4 m. 4·98 and 5·7 H.P.

No. 292. ι (35) HYDRÆ; 3½, 4 Lalande; 4 and 5 m. Harding; 4·39 Sir J. Herschel; 4·9 Johnson (1857); 4 m. Heis. The Cordoba estimates are 3·7 to 4·3 (*Uranometria Argentina*, p. 298); March 7, 1884, I estimated it at 3·7, one step brighter than θ Hydræ.

No. 293. κ HYDRÆ.—Not mentioned by Sufi; 4 m. Tycho Brahé and Hevelius; 4 m. and 6 m. Lalande; 4 Harding; 5 Heis; 5·4 Gould; 5½ Franks, March 2, 1878. 4·94 H.P. My observations are:—

April 25, 1875, κ a little fainter than υ^1 Hydræ.
March 28, 1876, κ more than half a mag. fainter than υ^1.
February 11, 1877, κ more than half a magnitude fainter than υ^1.
February 16, 1877, κ nearly one magnitude less than υ^1.
April 7, 1883, κ considerably less than υ^1—nearly 1 magnitude.

No. 294. LALANDE 19034 HYDRÆ.—4½ Lalande. Not given by d'Agelet or Piazzi; 6 m. Argelander, March 6, 1850; 4 m. February 16, 1851, and 5 m. March 8, 1852; 5 m. Heis, Houzeau, and Behrmann; 5·2 Gould. 4·62 H.P.

May 1, 1877, I estimated it 4½ m.; April 24, 1878, I found it the brightest star in the immediate vicinity.

No. 295. ψ LEONIS.—6 m. Sufi, Ulugh Beigh, and Argelander; 5 m Tycho Brahé and Hevelius; 6 and 6½ Lalande (19081–3). Sir W. Herschel gives ψ–7, and ψ, 8; 6 m. Heis; 5 and "Var" Houzeau; (1875·25); 6 m Franks, March 4, 1878. Smyth (*Bedford Catalogue*, p. 229) gives its magnitude as 6, assumed from Piazzi, but says it was "very bright for its rate" at the time of his observations. He adds, "They say it once disappeared altogether, after having been noticed by Montanari in 1667; and that Maraldi saw it again very small in 1691."

January 25, 1877, I observed ψ a little less than ν Leonis (5–6 Heis).

April 24, 1878. ψ brighter than 7, 11, and 23 Leonis, and the brightest star in its immediate vicinity.

February 21, 1884. Estimated 6·0—a little brighter than 3 Leonis.

No. 296. 16 LEONIS MINORIS.—6½ m. Lalande (19226–7); 6 Harding; 5 and 7·8 d'Agelet; 8 Piazzi; 7 m. Bessel and DM. Not in *Heis's Catalogue*, nor in *Argelander's Uranometria*; 5–6 Houzeau (1875·24); 7 Franks, "deep red," March 10, 1878. 6·64 H.P.

My observations are:—March 27, 1875, about 7½ m; January 19, 1876, 7¼ or 7½; February 10, 1877, a little less than a star *s p* λ and μ Ursæ Majoris; February 21, 1884, about 7 m—considerably less than 43 Camelopardalis; also less than 17 Leonis Minoris.

No. 297. 12 Sextantis.—6 m. Lalande (19542); 6·7 Heis; 6·5 DM; 6·8 Gould, who found it 6·1 at Albany, but the Cordoba estimates were 6·7 to 6·9.

February 18, 1877, I found it brighter than LL 19473 (6 m.).

This latter star is not in *Harding's Atlas;* I estimated it 6½ m. on the above date (and brighter than 9 Sextantis); March 7, 1884, I estimated 12 as 6·8 m.; April 2, 6·8 – less than 13, but brighter than LL 19473.

No. 298. 3428 B.A.C. Hydræ = LL 19634.—7 m. Lalande; 6–7 Heis; 7½ Franks, "deep dull yellow." March 2, 1878, Dr. Gould says it is not brighter than 7½ m. (*U. A.*, p. 303); April 7, 1883, I estimated this star 7·2 m.

It is 6–7 m. in the *Cape Catalogue* (1879·17).

No. 299. Lalande 19662 Sextantis.—4½ Lalande; 5 m. Harding; 7–8 Lamont (1845); 6–7 Heis. It does not seem to have been observed by either Argelander, d'Agelet, Bessel or Santini (*Nature*, May 13, 1875); Gould gives it 6·4 in the *Uranometria Argentina*.

In April, 1875, I found the star only 7 m.

February 15, 1877, less than 17 Sextantis (6–7 Heis).

February 11, 1880, less than 17 Sextantis.

April 7, 1883, estimated 6½ m.

No. 300. ♅ I. 163 Sextantis.—A nebula observed by Admiral Smyth, who says (*Bedford Catalogue*, p. 224), "It is remarkable that this object was very clearly distinguished in my telescope; for H. says it was scarcely perceptible in his twenty-foot when he gave it only six inches of aperture." According to Chambers it was "seen without the sligtest difficulty in a finder of 2½ in. by Brodie."

No. 301. υ^2 Hydræ.—5 m. Lalande and Harding; 5–4 Heis; 5 m. Franks, and = υ^1 Hydræ, March 2, 1878; 5–6 *Cape Catalogue* (1879·19). The Cordoba estimates vary from 4·5 to 5·2. 4·69 H.P.

March 28, 1876, I found υ^2 about ½ mag. fainter than υ^1 Hydræ.

April 7, 1883, υ^2 four steps fainter than υ^1.

April 8, 1883, υ^2 one step less than κ Hydræ, and four steps less than υ^1.

No. 302. Lacaille 4174 Carinæ.—7 m. Lacaille; 6½ Brisbane; 7 m. *Cape Catalogue* (1875·26). It was found generally below 7·0 m. at Cordoba, and Gould considers it "variable by not less than half a unit."

No. 303. LALANDE 19814 HYDRÆ.—6 m. Lalande, Harding and Heis; 5–4 Schmidt, 1864 (*A. N.* 1486); 5·9 in the *Uranometria Argentina*; 7 m. *Cape Catalogue* (1876·27). 5·34 H.P.

April 7, 1883, I estimated this star 5·7.

No. 304. 18 SEXTANTIS.—6 and 5½ Lalande (19828–9); 6 m. Argelander and Heis; 5 and 6 Piazzi; 6·5 Bessel; 5·9 Gould; 6 m. *Cape Catalogue* (1879·21). It is No. 234 of *Birmingham's Catalogue*, and Birmingham's observations vary from 6 to 6·5. Secchi thought it slightly variable. 5·85 H.P.

No. 305. LACAILLE 4176 VELORUM.—7 m. Lacaille. Variously estimated at Cordoba from 6 m. to 7¾.

No. 306.—VELORUM. Variously estimated from 7 to 7½ at Cordoba, and Gould thinks it "probably variable by about a unit."

No. 307. *q* CARINÆ = LACAILLE 4249.—4 and 5 Lacaille; 5 Ellery; 4 Behrmann. The Cordoba estimates vary from 3·3 to 4·5, and Dr. Gould calls it a "markedly red star."

No. 308. 40 LEONIS.—6 and 5½ Lalande (20017–19); 6–7 Heis. Not in *Argelander's Uranometria* 5½ Franks (1878) and = 41 Leo Minoris. Considered by Schmidt and Franks to be variable. 4·95 H.P.

No. 309. *r* VELORUM = LACAILLE 4271.—6 m. Lacaille; 5–6 Behrmann; 5·3 Gould, who says the estimates at Cordoba "differ on the average by the greater part of a unit of magnitude, and leave small room for doubt that these differences are due to actual changes in the star." The star is red.

No. 310. - LEONIS.—Included by Schönfeld in his provisional list. He says, "14° 2239 des Bonner Sternverzeichness, 9^m 5 Peters hat den Stern früher als schwach 11^m gesehen, April 23, 1873 vermisst, Juli 12 wieder schwach gesehen. Seit Dec. 30, im hiesigen Refractor unsichtbar. Die Veränderlichkeit ist wohl sicher, aber doch die Wiederscheinung und eine genaue Positionbestimmung abzuwarten."

No. 311. γ ANTLIÆ = LACAILLE 4277.—5 m. and 6 m. Lacaille; 6 Harding. Not in *Behrmann's Catalogue*; 7·2 Gould; 7 m. *Cape Catalogue* (1878·18). April 14, 1877, I found this star (in India) fainter than Lacaille 4273 (6½ m.). This latter star is not given by Harding, but was observed as 6 m. by Behrmann, and is 6·6 in the *Uranometria Argentina*.

No. 312. 27 SEXTANTIS.—6 m. Lalande; 6 m. Heis; 6·8 Gould; 6½ Franks (= 24, 26), March 13, 1878 (*private letter*); 6 *Cape Catalogue* (1879·24). 6·54 H.P.

My observations are :—February 15, 1877, 27, nearly 1 mag. less than a star *n* of it (6-7 Heis) (and between it and 29), or about mag. 7; February 11, 1880, about half a mag. less than Heis's 6-7 m. star, or about 6·8.

No. 313. *α* Antliæ.—4 m. Lacaille; 4·75 Sir J. Herschel (*Cape. Obs.*, p. 341); 5-4 Behrmann; 4 m. Heis. The Cordoba estimates vary from 4·0 to 5·0, and Dr. Gould thinks "cannot be explained by personal differences due to the red colour of the star" (*U. N.*, p. 295); 4 m. *Cape Catalogue* (1878·21). 4·50 H.P.

No. 314. I Carinæ.—4½ m. Lacaille; 5 Behrmann. The Cordoba estimates vary from 4·2 to 5·1, and Dr. Gould seems to think the variability certain. 4-5 m. *Cape Catalogue* (1874·23).

No. 315. Lacaille 4332 Velorum.—6½ m. Lacaille. The Cordoba estimates vary from 6½ to 8·0.

No. 316. 49 Leonis.—6 m. Harding; 7 Santini; 6 Heis; 6 m. Houzeau (1875). Sir W. Herschel gives the sequence 48 , 49 , 44. It is No. 7 of Schönfeld's provisional list. He says, "February 5, 1867, 5·6 m., später abnehmend A. N. 69·1635. Meine Beobachtungen zeigen den Stern völlig constant." 5·74 H.P.

February 11, 1877, and March 21, 1877, I found it = 44 Leonis, but less than 48 Leonis. It was estimated 6·0 by Gould, who finds no evidence of variation.

No. 317 Lacaille 4358 Antliæ.—7 m. Lacaille; 6 m. Brisbane and Taylor. Not given by Behrmann. The Cordoba estimates vary from 5·7 to 6·5. Dr. Gould calls it a "brilliantly red star." 6 m. *Cape Catalogue* (1877·56).

No. 318. — Leonis.—An 8 m. star, with rapid variation, according to Schwab (*Cel. Obj.*, 4th ed., p. 428).

No. 319. *t'* Carinæ.—5 m. Lacaille; 6-5 Behrmann. The Cordoba estimates range from 5·4 to 6·3, and Dr. Gould seems to think it certainly variable.

No. 320. Lacaille 4411 Chamæleontis.—5 and 6 m. Lacaille; 6 and 6½ Ellery (1864); 6-5 *Cape Catalogue* (1873·30). Estimated only 7·0 at Cordoba (March, 1878).

No. 321. Lalande 20592 Leonis.—No magnitude given in *Lalande's Catalogue;* 9½ m. Hencke (*Mon. Not. R. A. S.*, 1859, p. 341), who suspected variation, as it was missed at Markree Observatory. It is not in *Harding's Atlas.*

No. 322. Star *s p* 40 Leonis Minoris.—6 m. Harding (marked with a line). Not in *Lalande's Catalogue.* I could not see this star

with the binocular on February 11, 1877. On February 12 I found a 10 m. star close to the place, with 3-inch refractor. The star may possibly be variable. It lies a few minutes of arc *s p*, the star Lalande 20612. The position given in the catalogue is only approximate.

No. 323. t^2 CARINÆ.—5 m. Lacaille; 5-6 Behrmann. The Cordoba estimates vary by 0·6 m. Gould calls it "orange red."

No. 324. 2543 R URSÆ MAJORIS.—Not in *Harding's Atlas;* 6-7 Heis. Franks says, "6½ m. fine red (1878), 1½° S. of P.X. 126 (=B.A.C. 3652), a little *f*" (*private letter*). March 15, 1884, I estimated it 6·7 m.

No. 325. LACAILLE 4422 CARINÆ.—6 and 6½ Lacaille; 7½ Taylor; 5 and 5½ Ellery; 6-7 *Cape Catalogue* (1875·85). From observations at Cordoba, Thome is confident of its variability (*Uranometria Argentina*, p. 254).

No. 326. LACAILLE 4435 CARINÆ.—6 m. Lacaille; 6-5 Behrmann. Suspected variable by Gould, the Cordoba estimates varying from 6·1 to 6·7. The star is red.

No. 327. *w* CARINÆ (= LACAILLE 4446).—6.5 Behrmann. The Cordoba estimates vary from 4·8½ to 5·4, and Dr. Gould considers it possibly variable. It is a red star.

No. 328. LACAILLE 4479 CARINÆ.—The Cordoba estimates vary from 6·7 to 7·2, and Gould considers variation probable between still wider limits.

No. 329. LALANDE 20918 HYDRÆ.—6½ Lalande; 6 m. Argelander. Estimated 7·3 at Cordoba, July 6, 1871, but only 8 m. May, 1877. Dr. Gould calls it "very red" (*Uranometria Argentina*, pp. 303, 304). It is No. 248 of *Birmingham's Catalogue.* Birmingham's observations vary from 7 to 8.

No. 330. – LEONIS.—Suspected variable by Professor C. H. F. Peters, from observations at Clinton, U.S.A., 1877 to 1880. He found an observation of it as 9 m., February 12, 1872, but could not see the star on the following dates:—April 12, 1877, and May, 1877; February 26 and April 14, 1878; April 27, May 2, and 11, and June 2, 1880; but saw it very small February 16, 19, and March 2, 1880 (AN 2360). Probably this star should be transferred to *Catalogue of Known Variables.*

No. 331. b^3 HYDRÆ.—5 m. Lalande (20969); 5 m. Heis; 6 m. Franks, March 13, 1878. Argelander's meridian observations vary from 4·8 to 6·0. The Cordoba estimates range from 5·2 to 5·7. 5·19 H.P.

No. 332. Lacaille 4540 Antliæ.—6 m. Lacaille; 6-5 Behrmann. Gould says, "This star appears to vary between the approximate limits $5{\cdot}7^m$ and $6{\cdot}3^m$."

No. 333. α Ursæ Majoris.—2 m. Ptolemy, Sufi, Lalande, and Harding; 1·96 Sir J. Herschel (*Cape Obs.*, p. 440); 1·88 Pritchard, Oxford, and 1·92, Cairo, 1883. 1·96 and 2·1 H.P.

Stated by Klein to be variable in colour, and the observations of Weber seem to confirm the suspicion. The latter observer found a period of about 33 days, and the changes of colour from "white" to "fiery red." Other observers, however, do not agree.

No. 334. Struve 1504 Leonis = P.X. 229.—A double star, 8, 8 : 284°·0 : 1″·13. With reference to this star, Chambers says in his edition of Smyth's *Bedford Catalogue* (p. 288), "According to O. Struve, one or both of the components are variable.

No. 335. 10 Hydræ = Lacaille 4615 (6 m.).—Suspected variable by Gilliss, who says, "Probably variable at very short intervals; of the seven observations three estimations make it 6th magnitude, three 5th, and the other 5–6." It was rated 5 m. by Argelander, March 15, 1880; 7 m. April 22, 1851; and 6 m. April 28, 1851. It is 5 m. in *Harding's Atlas*, and was rated 5 m. by Heis; 5–6 Behrmann, and 5·8 at Cordoba. The following observations were made by me in India:—May 15, 1876, about 5 m. and slightly less than χ^1 Hydræ; May 23, 1876, 10 Hydræ about ½ a mag. less than χ^1; January 22, 1877. Brighter than χ^2; not quite equal to χ^1. It is 5·35 in H.P.

No. 336. Lacaille 4623 Hydræ.—4 m. and 5m. Lacaille; 5 Heis; 5–6 Behrmann. The Cordoba estimates vary from 5·6 to 6·1; 6 m. *Cape Catalogue* (1878·78).

No. 337. H II. 49 Leonis.—A nebula suspected by d'Arrest to be variable. In 1831 it was brighter than Herschel's III. 27, *f* it. In 1861 = I. class; in 1863 sometimes = II. class, at others invisible; 1864 fainter than Herschel's III. 27 (*Cel. Obj.*, p. 333).

No. 338. φ Leonis.—4 m. Sufi, Lalande, and Harding; 5–4 Argelander and Heis; 4·8 Gould (at Albany) and 4·1 to 4·3 at Cordoba. Dr. Gould says it "appears to have grown brighter since Argelander and Heis gave its magnitude as 4⅔" (*U. A.*, p. 336). 4·31 Pritchard (1882·36). March 7, 1884, I estimated it 4·8, less than υ (4·4 Gould); March 23, 1884, 4·5 m. 4·53 H.P.

No. 339. Lacaille 4679 (1882·36). Hydræ.—7 m. Lacoille. Numerous estimates at Cordoba vary from 7·0 to 7·7.

No. 340. Σ 1527 Leonis = Lalande 21571 (7 m.).—7·4 in DM; 7 Bessel; 6·7 Gould. A double star 6·9,8·1 : 10°·1 : 3″·9. Webb says, "Fl. bin. (?) 6·9 var. col. and mag. (?)" (*Cel. Obj.* 4th edition, p. 330).

No. 341. ι LEONIS.—3½ Lalande; 4 m. Argelander and Heis; 4·0 Gould; 4 m. Franks (nearly = β Virginis), March 29, 1878 (*private letter*); 4·18 Pritchard (1882·360). A double star 3·9, 7·1 : 68°·4 : 2″·54 (1877 Dembowski). Both the magnitude and colour of the companion are suspected of variation. Sir W. Herschel found 77 (σ), 78 (ι) – 91 (υ). 3·98 H.P.

April 17, 1876, I found ι and σ Leonis nearly equal, σ (4–5 Heis), if anything slightly the brighter of the two; March 4, 1884, ι one step less than σ, or about 4·2 m.

No. 342. – TAURI.—A nebula discovered by Temple, March 14, 1879, in a region which had been most carefully searched for such objects. It was at first supposed to be a faint comet, but its unchanged place on March 16 showed its true character. According to Temple it has two nuclei, distant 15″ to 20″, and is larger and brighter than Herschel II. 32, which lies near it. It is not in *Lassell's Catalogue* of 600 nebulæ discovered at Malta. It precedes a 7 mag. star (W. B. XI. 305), 1 m. 27 s. nearly on the parallel. Chacornac in his Chart No. 34 shows a 12·13 m. star about 3′ from the place of the nebula, but shows no nebulosity (*Nature*, May 8, 1879).

No. 343. 57 URSÆ MAJORIS.—A double star 6, 9 : 9°·9 : 5″·9. Smyth remarks (*Bedford Catalogue*, p. 253), "♅ says that the small star is a "red point without sensible magnitude;" and S, upwards of half a century afterwards rates it of the 10th lustre, as shown by his seven foot telescope. In the summer of 1835 it was very distinct, being a bright 9th size, bearing illumination admirably. Is it variable?" Burnham gives 5·2, 8·2 : 7°·1 : 5″·43 (1878·425). Heis rated 57 as 5 m. and Peirce measured it with a photometer 5·40 (*Harvard Annals*, vol. ix.). It is 5·24 and 5·0 "est" in H.P.

No. 344. LALANDE 21860–61 LEONIS.—6 and 5½ Lalande; 7 Bessel; 7·5 in DM; 6–7 Heis, and 6·9 at Cordoba. Suspected variable by Gould, although included in his "Standards of Magnitudes" (*Uranometria Argentina*, p. 28). He adds, however, that "no change has been perceived in its brightness" at Cordoba (*Uranometria Argentina*, p. 336). April 2, 1884, I estimated it 6·7 m.—one step brighter than LL 21640, but less than LL 22058.

No. 345. λ DRACONIS.—3–4 Sufi, Argelander, and Heis. Sir W. Herschel gives λ·κ, or about equal; 4 m. Harding; 3·94 Sir J. Herschel; 3·3 in DM; 3·75 Pritchard (1882·712). My observations are:—January 30, and February 17, 1876, λ slightly less than κ draconis, and of an orange hue, not brighter than δ Ursæ Majoris; June 12, 1877, λ slightly brighter than κ, and of an orange hue; April 9, 1883, λ yellow, or light orange, and two steps less than κ Draconis.

No. 346. 17 Hydræ = Lacaille 4770 (N. Hydræ, Gould).—4½ m. Lacaille; 5·2 Gould (dpl. 6, 6).—A double star, 5·5, 7 : 207°·8 : 10″·1, 1833; Webb found only half a mag. difference, 1852; so Morton, 1857; and Franks, 1876 (*Cel. Obj.*, p. 286). I found 7 rather the larger in 1875; both yellowish (*Southern Stellar Objects*, p. 52). 4.98 H.P.

No. 347. Lacaille 4843 Muscæ.—6 m. Lacaille; 5–6 Behrmann; 6–5 *Cape Catalogue* (1875·41). The Cordoba estimates vary from 5·4 to 6·1, and Gould thinks it "probably variable."

No. 348. 92 Leonis.—5½ m. Lalande (22,111); 5 Argelander and Heis; 6 m. Houzeau (1875·26); 6 Franks, "pale orange," scarcely = 67 Leonis (6–5 Heis). It is not in *Birmingham's Catalogue of Red Stars*. Sir W. Herschel gives 95 (o), 92. March 3, 1884, I found it two steps brighter than 67, but less than 72 Leonis. 5·48 and 5·3 H.P.

No. 349. β Leonis.—Considered by Sir W. Herschel (*Phil. Trans.*, 1796) to have probably diminished in brightness in modern times. It was rated of the 1st magnitude by Ptolemy, Sufi, and Tycho Brahé; 1–2 by Flamsteed; 1½ m. by Hevelius; but only 2 m. by Lalande, Argelander, and Heis. Sir W. Herschel rated it slightly less than γ Leonis, and remarks, "From the expression of this Catalogue, it is evident that the star is less now than it was thirteen years ago." In Schjellerup's translation of Al-Sufi's description of the heavens (10th century) the star is thus described:—"La 27 [β] de la première grandeur est la brillante et grande qui se trouve sur la queue; elle suit la brillante vingtième etoile située dans les reins C'est celle que l'on marque sur l'astrolabe et que l'on nomme *dzana al ásad*, la Queue du Lion." From this it is evident that the star was a brilliant one in Al-Sufi's time, probably comparable in brightness with Regulus, which Sufi describes in similar words. Sir John Herschel rated it 2·63 (*Cape Observatory*, p. 440) (γ Leonis = 2·34); Pritchard 2·07 (1882·360 and 1883·117). 2·23 H·P.

No. 350. β Virginis.—2, 3, 3½, and 4 m. Lalande; 3 Harding; 3-4 Heis; 4·14 Sir J. Herschel, February 24, 1838; 3·3 Gould at Albany, and 3·7 at Cordoba; 3·67 Pritchard (1883·160 and 1883·169). 3·72 H.P.

No. 351. 65 Ursæ Majoris.—A triple star 7, 9·5, 7: 35°·8, 115°: 3″·8, 63″·5. Measured 6·39 by Peirce (*Harvard Annals*, vol. ix.). Smyth says: "The magnitude which I have assigned, on mature comparison to B, does not altogether quadrate with ♅'s description of its being a mere point, which would hardly be suspected. It may be variable; and I have reason also to think C is" (*Bedford Catalogue*, p. 260). On March 15, 1880, and March 30, 1881, I found it about half a magnitude brighter than C, (with 3-inch achromatic); B not seen.

No. 352. η CRATERIS.—4·3 Ptolemy; 5–6 Sufi; 4 m. Ulugh Beigh, Tycho Brahé, and Hevelius; 4, 4½ Lalande; 6 m. Heis and Argelander; 5·4 Gould; 6–7 Houzeau. "var?" (1875·25); 5 m. Franks "= ϵ and bright white," March 29, 1878; 5·6 *Cape Catalogue* (1879·24). In April, 1876, I estimated the difference between ζ (5 m. Heis) and η to be rather less than one magnitude; April 15, 1877, η nearly equal ζ. The star seems certainly variable. 5·01 H.P.

No. 353. 7 (b) VIRGINIS.—Marked 4 m., and "variable" in *Dien's Atlas* (Flammarion's edition); 5½, 6 Lalande (22571–2); 6 Argelander; 6–5 Heis; 5·8 Gould; 5½ Franks, March 29, 1878 (*private letter*). April 6, 1883, I found 7 Virginis more than half a magnitude brighter than 10, and three steps brighter than 11 Virginis; 10 seems rather below than above 6 m.; April 7, 1883, the above observation confirmed—10 not above 6 m. 7 is 5·22 and 5·7 in H.P.

No. 354. 31 CRATERIS.—6 and 4½ Lalande (22591–2); 6 Heis; 5·5 Gould (No. 4 of Corvus); 5 Franks = η, March 29, 1878; 5–6 *Cape Catalogue* (1879·23). In April, 1875, I found this star about = η Crateris; not equal to ζ (5 m.). In April, 1876, it seemed very nearly equal to ζ. 5·10 H.P.

No. 355. LACAILLE 5013 HYDRÆ.—7 m. Lacaille; 6, 7, and 6½ Yarnall; 6–7 *Cape Catalogue* (1878·29). Dr. Gould says "the variability of this star seems more than probable, our eleven estimates ranging from 5·9 to 6·6."

No. 356. ϵ CORVI.—3 m. Ptolemy and Sufi. Rated 6 times as 4 m., and once 3½ by Lalande; 4 Harding; 3 Argelander, Heis, and Behrmann; 3·3 at Cordoba; 3·28, Sir J. Herschel (or very slightly less than δ). Sir W. Herschell gives β, ϵ, δ. 3·14 H.P.

From the Cordoba observations, Dr. Gould concludes that all four stars, β, γ, δ, and ϵ Corvi are variable "within moderate limits" (*Uranometria Argentina*, p. 315). The estimates for ϵ vary from 3·06 to 3·51.

No. 357. 3 CORVI.—6 m. Lalande (22850); 6 Harding; 6–7 Heis; 6 Behrmann; 5·8 in the *Uranometria Argentina.* Sir W. Herschel gives 5 (ζ) — 3 —, 6; 6–5, *Cape Catalogue.* 5·25 H.P.

No. 358.—VIRGINIS. = DM o°, 2910. Found to be variable by Prof. Harrington of Ann Arbor University, U. S. A., in 1881. It reached a minimum on May 22–3, when it was 8·7m. The star is not in *Lalande's Catalogue,* nor in *Harding's Atlas.* The position given by the discoverer places the star about 1½° p the star η Virginis. The nearest star in *Harding's Atlas* is an 8m, about 20′ south.

No. 359. δ Ursæ Majoris.—3–4 Sufi and Argelander; 4–3 Heis; 3·38 Pritchard (1883·062 and 1883·070). Pigott says (*Phil. Trans.* 1786): "This star is suspected to change in brightness (see *Long's Astronomy*) on account of its being marked by Tycho, Prince of Hesse, &c., of the 2nd mag.; while Hevelius, Bradley, and others have it of the 3rd. At present, and for these three years past, it appears as a bright 4th magnitude, being rather less than ι, equal to α, and rather brighter than κ Draconis." Schönfeld includes it in his provisional list, and says (? quoting Schmidt): "Hinlänglish bestätigt, lange Periode AN 73 1745." 3·41 and 3·6 H.P.

No. 360. γ Corvi.—3m Sufi, Lalande and Harding; 2 Heis; 2·90 Sir J. Herschel (*Cape. Obs.* p. 440); 2·5 at Cordoba. From the *Cordoba Observations*, Dr. Gould concludes that the four stars of Corvus, β, γ, δ, and ε are all variable "within moderate limits" (*U. Argentina*, p. 315). The estimates for γ vary from 2·45 to 3·05. 2·76 and 2·3 H.P.

In March, 1876 (in India) γ seemed to me about 2½m, and about equal to κ Orionis; γ certainly less than the brighter stars in the Plough (2m Heis).

No. 361. ε Muscæ.—4½ and 6 Lacaille; 5–4 Behrmann; 3·7 Ellery; 5 *Cape Catalogue* (1874·41). The Cordoba estimates range from 4·3 to 5·3, but Dr. Gould seems to think the results doubtful, owing to the red colour of the star.

No. 362. η Virginis.—3 Ptolemy and Sufi; 3½ and 3 Lalande; 3–4 Argelander and Heis; 3·6 Gould at Albany, and 4·0 at Cordoba. Dr. Gould says: "The star probably varies between the magnitudes 3 and 4." 3·59 Pritchard (1882·363) March 28, 1876, I found η = β Virginis.

April 5, 1883 η, three steps less than δ Virginis. 4·05 H.P.

No. 363. ε Crucis.—4m Lacaille; 4–5 Behrmann; 4·0 Gould. Webb says: "Lettsom 1860 found this star 6mg, instead of 4mg as in map. Houzeau, 1875, 4·5mg" (*Cel. Obj.*, p. 488). Gould marks it "rr" or excessively red.

No. 364. 4166 B.A.C. Ursæ Minoris.—Not in *Heis's Catalogue.* Feb. 24, 1884, a small star about 9m seen near the place with binocular. 8 m. Tennant, April 24, 1875.

No. 365. Lalande 23228.—9 Virginis. 7m Lalande (1795) and 5½ (1798); 7 Harding; 6–7 Lamont; 8m Steinheil; 6 Heis; 6·1 Gould. Not given by Piazzi, Bessel or Santini. I found it about 6m, and brighter than Lalande 23186, March, 1877. 5·95 H.P.

No. 366. Lacaille 5142 Centauri.—6m Lacaille. The Cordoba estimates vary from 5·6 to 6·2, and Gould suspects variation to the extent of about half a magnitude, (*U. A.* p. 266).

No. 367. BIRMINGHAM 277 VIRGINIS.—A remarkable "red orange" star. Not in *Lalande's Catalogue*; 8·1 Argelander; 7·5 Bessel; 6m Lamant (Z 93.); Birmingham's estimates of magnitude, 1872–1876, vary from 6–6·5 to 7–7·5; 7m Webb, 1874, Ap. 20, and May 8. The star is not in the *Uranometria Argentina*. d'Arrest found a very interesting spectrum "all the more refrangible rays totally absorbed—a fragment of a star spectrum." I found the star below 7m, April 7, 1883.

No. 368. 4193 B.A.C. URSÆ MINORIS.—Not in *Heis's Catalogue*. February 24, 1884, a small star, about 9 m., seen near the place with binocular. 8·5 m. Tennant, April 24, 1875.

No. 369 δ CORVI.—3 m. Sufi, Lalande, and Harding. Sir W. Herschel gives 9 (β), 7 (δ)—1 (α); 3·22 Sir J. Herschel (*Cape Obs.* 344; 2–3 m. Heis: 3·0 at Cordoba; 3 m. Franks, April 2, 1878. In March, 1876, it seemed to me nearer 3 m. than 2 m. From the observations at Cordoba Dr. Gould concludes that the four stars β, γ, δ, and ϵ Corvi are all variable "within moderate limits." The estimates for δ vary from 2·84 to 3·49. 3·13 H.P.

No. 370 TAYLOR 5747 CORVI.—6 m. Taylor; 7 Piazzi; 5·7 Johnson. It seems to be 11 Heis Corvi, where it is rated 6–7. Not in *Argelander's Uranometria*; 6 m. Behrmann. The Cordoba estimates vary from 5·8 to 6·5 (*U. A.* p. 318). 5·98 H.P.

No. 371. BIRMINGHAM 281 VIRGINIS.—8·5 Argelander and Bessel; 9·5 Earl of Rosse ("scarlet"); 9·5 Birmingham ("no colour"), May 8, 1874.

No. 372. γ CRUCIS.—2 m. Lacaille; 1·73 Sir J. Herschel; 2–1 Behrmann; 2·0 Gould, who considers that this star is probably variable, as "its magnitude has been variously estimated from 1·8 to 2·4 even by the same observer" (*Uranometria Argentina*, p. 269).

No. 373. η CORVI.—4 m. Sufi; 4½, 5 Lalande; 5 Harding; 5 m. Argelander and Heis. Sir W. Herschel gives 1 (α)—8 (η)—5 (ζ). April 29, 1875, I found η a little brighter than ζ Corvi. 4·45 H.P.

No. 374. β (8) CANES VENATICI.—5 m. Sufi; 4½, 5 Lalande; 5 Harding; 4–5 Heis; 4·54 Peirce; 4·56 Pritchard (1882·449). Smyth says, "Suspected of variability" (*Bedford Catalogue*, p. 272). 4·30 H.P.

No. 375. β CORVI.—Smyth suspected variation; and says (*Bedford Catalogue*, p. 271) it "has unquestionably the precedence of lustre Corvus, which could hardly have been the case in Bayer's time; and what is singular, it has no trivial Arabian designation." Dr. Gould suspects variation; the Cordoba estimates varying from 2·62 to 3·10. Sir W. Herschel, in 1783, found the order of brightness—β, γ, δ–α.

Sir J. Herschel's estimate was 2·95 (*Cape Obs.*, p. 440). β seemed to me nearer 3 m. than 2 m. (in India), March, 1876. 2·81 H.P.

376. 24 Comæ.—5½ and 6 Lalande; 7 m. Bessel; 4·3 in DM; 5 m. Argelander, Heis, and Gould; and 5·4 at Cordoba. Suspected variable by Gould, although included by him in his "Standards of Magnitude" (*U. A.* p. 28). June 12, 1877, I found 24 very slightly less than 23 Comæ; March 15, 1884, I estimated it 4·9; brighter than 11 Comæ; April 7, 1884, 4·8—two steps brighter than 23 Comæ. 4·98 H.P.

No. 377. DM 17°, 2510 Comæ.—Said to be variable by Weiss, from 8·8 to 10 in about 11 months.

No. 378. 9 Canes Venatici.—5·8 Argelander; 6 Heis; 6·23 Peirce; 6·9 DM. Peirce says, with reference to this star (*Harvard College Annals*, vol. ix. p. 140): "The magnitude of Argelander and Heis differ very much from that of the DM, and my measures are discordant. But I have excluded the star from the group, not so much on suspicion of variability as because I do not feel sure that I always observed the same star, as there are three near together." Harding only shows one star (9 m.) near the place. December 23, 1878, I found 9 less than 10—one or two faint stars seen close to it with the binocular. 6·13 H.P.

No. 379. DM 17°, 2511 Comæ.—Said to be variable by Weiss to the extent of one magnitude in a period of about 9½ months. It seems to be Lalande 23645 (8 m).

No. 380. Lalande 23675–6.—7 m. and 7½ m. Lalande and 7 m. Harding; 6m Argelander, but seen as 5m by Heis; 5·7 Gould. It is a double star Σ 1669 (6·5, 6·5: 298°·9: 5″·4). Dr. Gould says: the Cordoba estimates are accordant (*U. A.* p. 318). 5·29 H.P.

In June, 1875, I found it about 5½m, and brighter than the stars Lalande 23446, and Lalande 23463.

No. 381. γ Virginis.—3 m. Ptolemy, Sufi and Lalande; 3–2 Argelander; 3–2 Heis; 3·14 Sir J. Herschel (*Cape. Obs.*, p. 440); 3·1 Gould; 3 m. Franks (slightly > δ), April 2, 1878, (*private letter*); 2·67 Pritchard (1882·363). 2·84 H.P.

March 28, 1876, I found γ Virginis = γ Corvi (2m Heis).

April 5, 1883, γ Virginis seemed nearer 2m than 3m.

It is a celebrated double and binary star, and Struve thought the components alternately variable in brightness, with a possible period of at least several years. Fletcher held the same opinion (*Cel Obj.*, p. 412) (*English Mechanic*, June 15, 1883).

No. 382. Lalande 23726.—7½ m. Lalande; 8 Bessel (1824); 5 Heis; 5 Houzeau (1875·13). It is 8 m in *Harding's Atlas*, and is very probably variable. Dr. Gould says: "It has never in our observations been found brighter than 6^m 9."

My observations are: June 7, 1875, 8 m.; March 1876, 7 or 7½m.

No. 383. BIRMINGHAM 290 CANES VENATICI.—5½ Lalande (23793); 6 Harding; 5·4 in *Durchmusterung*; 5–6 Heis; 5·16 Peirce. Variously estimated by Birmingham (1872–1876) from 4·5 to 6·5. It is included by Schönfeld in his provisional list. He says, (quoting Schmidt): "Aug. 1872, kaum 6 m. bis Mitte Dec. zunehmend, 1873 Mitte Juni wieder einem Minimum nahe. Roth "AN 82, 1952." On Feb. 28, 1878, I found the star 5½m, and the brightest star in the immediate vicinity; the orange colour perceptible with the binocular. Schmidt observed a maximum 1876, April 2, and a minimum on Aug. 15, and deduces a period of 380 days. Feb. 21, 1884, I estimated it 6m.

No. 384. LALANDE 23824–5 VIRGINIS.—6 and 7m Lalande; 5·9 Gould (Albany), and 6·5 at Cordoba Gould remarks, "there is reason for suspecting the constancy of its light." He adds, however, "No variation has been observed at Cordoba" (*U. A.*, p. 318).

No. 385. LACAILLE 5300 CENTAURI.—6½ Lacaille; 5½ Brisbane; 7 Taylor. Gould remarks: "For this star our estimates are very discordant, suggesting variability."

No. 386. STRUVE 1686 COMÆ.—A double star 8, 8·2: 187°·6: 5″·4. Components suspected of relative change of magnitude. It seems to be Lalande 24006 (8m.).

No. 387. ε URSÆ MAJORIS.—2m Ptolemy, Sufi and Argelander 3m Lalande; 1·95 Sir J. Herschel (*Cape Obs.*, p. 440). 2 m Heis. Suspected by several observers to be slightly variable, 1·80 Pritchard (1882·938). 1·85 and 2·1 H.P.

No. 388. DRACONIS.—A red star, discovered by Burnham. 7 m. Harding; 7·3 Argelander; 7 m. Burnham. My observations are:—

November 28, 1878, about 8 m. equal to an 8 m. star *preceding*.
January 1, 1879, seems a little brighter; perhaps 7½ m.
October 7, 1879, about 8·2, slightly less than the star *p*.
February 8, 1880, about two steps brighter than the star *p*.
March 8, 1880, two steps brighter than the star *p*.
December 1, 1880, two steps brighter than the star *p*.
Januery 9, 1882, one step brighter than the star *p*.
October 15, 1882, two steps brighter than the star *p*.

No. 389. LACAILLE 5344 CENTAURI.—7 m. Lacaille. The Cordoba estimates vary from 6·3 to 7·0, and Dr. Gould thinks "leave small doubt that the star is variable by about half a unit of magnitude."

No. 390 ε VIRGINIS.—3–4 Ptolemy; 3 Sufi; 3–2 Argelander and Heis; 3·11 Sir J. Herschel (*Cape Obs.* p. 345) 3·01 Pritchard (1882 ·363). Admiral Smith suspected it to be "slightly variable" (*Bedford Catalogue*, p. 290). 3·00 and 3·3 H.P.

No. 391. – Virginis.—"Bayer's star of 6th magnitude, 1° south of *g* Virginis." Suspected variable by Pigott, who says, "This star is not in any of the nine catalogues that I have. Maraldi looked for it in vain, and in May, 1785, I could not see the least appearance of it. It certainly was not of the 8th magnitude." It may possibly be either Lalande 24283–4 (7½, 9½) or Lalande 24393 (7½). The latter answers better to Bayer's description, but the position of the former agrees more closely with the place given by Pigott (R.A. 12^h 53, S. 10° 00 for 1786).

No. 392. Lacaille 5397 Centauri.—6½ Lacaille; 8 Brisbane; 6 m. Taylor; 5·2 Yarnall; 6·3 Gould. The Cordoba estimates show discordances of 0·6 magnitude.

No. 393. ψ Hydræ.—6 m, Lalande; 5 m. Heis and Behrmann; 5·3 Gould; 5 m Franks, 1876, and 6, 1878. 5·13 H.P.

No. 394. 50 Virginis.—9 and 7 m. Lalande (24434–6); 7 Harding; 6 Piazzi; 7 m. Argelander; 6·2 to 6·5 at Cordoba (*Uranometria Argentina*, p. 319).

No. 395. Lacaille 5412 Centauri.—7 m. Lacaille. "Mr. Thome is confidant of having seen this star at the magnitudes 6·7 and 7·2, as well as at intermediate degrees of brightness" (*Uranometria Argentina*, p. 267).

No. 396. – Virginis.—About 40′ *sf* 53 Virginis. Not in *Lalande's Catalogue*, or *Harding's Atlas*. Suspected by Olbers in 1797 to be a remarkable variable. He found it the brightest star in the immediate vicinity of 53 Virginis. In July and August, 1876, Tebbutt, at Windsor, N. S. W. estimated it at 8½ m. On May 10 and 11, 1876, I found it 9 m., and equal to Lalande 24421 (Olber's star *c*), but brighter than Lalande 24597 (Olber's star *d*) (See *Nature*, April 13, 1876). Lalande 24597 seemed to be about 9½ or 10 m, though rated 11 m. by Olbers.

No. 397. Lacaille 5460 Centauri.—7 m. Lacaille. Dr Gould says, "is a red star, which seems to be variable between the limits 7^m and $7\frac{1}{2}^m$."

No. 398. γ Hydræ.—4–3 Ptolemy; 3–4 Sufi; 3 Tycho Brahé, and Hevelius, Argelander and Heis; 4 m. *Armagh Catalogue*; 3·46 Sir J. Herschel (*Cape Obs.*, p. 433); 3·2 Gould. Birmingham, in the notes to his *Catalogue of Red Stars*, says, May 9, 1869: "5 mag. at most; yellow, with lines in the green *Sugli Spetri*," &c., Margo, 1872. Type II.: lines and zone var—*Prodromo*, &c., 1876. 3·35 H.P.

No. 399. Struve 1734 Virginis.—Lalande 24747; 7 m. Hencke; 6·7 Gould. A close double star, 7·2, 7·9 : 198°·1 : 0″·7. Secchi suspected the smaller component of being "changeable" (*Cel. Obj.* p. 414).

No. 400. 63 VIRGINIS.—6 m. Lalande (24792); 5 m. Harding; 6 Heis; 5·5 Gould; 6 Franks. April 14, 1878 (*private letter*). The estimates at Cordoba range from 5·2 to 5·9, and Gould thinks "leave no doubt of a variation to that extent in its brightness." 5·50 H.P.

No. 401. 68 (i) VIRGINIS.—5½ Lalande; 5 Harding; 6 Argelander and Heis; 5·7 Gould; 6 Franks (=75) April 4, 1878; 6·03 Espin, measured with photometer, March 30, 1883. Birmingham's estimates 1873–1876 vary from 5 to 6. He says Secchi found it "scarcely 8 mag." 9 May, 1869. 5·52 H.P.

No. 402. 69 VIRGINIS.—5½ Lalande (24891); 5–6 Heis; 5·0 Gould. Suspected variable by Gould, from observations at Cordoba, which vary from 4·8 to 5·4, and he thinks the variation may possibly be greater (*U. A.*, p. 319). 5 m. Franks (=53) Ap. 4, 1878. 4·85 H.P.

No. 403. 72 VIRGINIS.—6 m. Lalande (24975-6); 6 Harding. Not in *Heis's Catalogue*. 6·7 at Cordoba. Suspected variable by Gould, who says, "There are indications of variation by about half a magnitude in the brightness of this star" (*U. A.*, p. 319). 6·14 H.P.

No. 404. - VIRGINIS.—Suspected by Hind to be variable. It is not in *Lalande's Catalogue*.

No. 405. 76 VIRGINIS.—6 m. Sufi; 5 Argelander and Heis; 5·8 Gould; 5½ Franks, April 4, 1878. Espin's estimates of magnitude in March and April, 1883, vary from 5·63, with photometer, to 5·90, estimated with opera glass. 5·54 H.P.

May, 1 1877, I found 76 slightly less than 82 and 86 Virginis, which Heis rated 6 m.

April 6, 1883, 76 2 steps less than 82 Virginis.
April 7, 1883, do. do. do.
April 9, 1883, do. do. do.

No. 406. LACAILLE 5590 CENTAURI.—7 m. Lacaille. The Cordoba estimates fluctuate between 6·5 and 7·2.

No. 407. ζ VIRGINIS.—3-4 Sufi; 3-4 Argelander and Heis; 3 m. Lalande; 3·88 Sir J. Herschel (*Cape Obs.*, p. 345) (δ Virginis = 3·90) 3·2 Gould, 1858; 3·6 at Cordoba (1871, four observers).); 3½ Franks (= δ) Ap. 4, 1878 (*private letter*); 3·36 Pritchard (1882 363). 3·53 H.P.

April 26, 1876, I found ζ distinctly *brighter* than δ; ζ about 3 m.
August 2, 1877, same as last observation.
March 12, 1880, ζ distinctly brighter than δ, though at a much lower altitude.
April 5, 1883, ζ about three steps brighter than δ, but less than γ.

No. 408. Lacaille 5601 or 5602 Centauri.—In the *Cape Catalogue*, 1881, Stuve remarks:—"Only one seventh magnitude was seen near this place, although two stars, Lacaille 5601 and 5602, were observed by Lacaille on 1752, February 12."

No. 409. 65 Heis Canes Venatici = B.A.C. 4545.—6 m. Lalande (25157); 6 m. Harding; 6 Heis; 6·88 Peirce, who says:—"Argelander and Heis make this 5·8; I, 6·9. They make it equal to 60 Heis; the DM makes it 0·3 fainter; and I 0·7 fainter. Argelander; and the DM make it equal to 73 Heis; Heis makes it 0·5 brighter; and I, 0·1 fainter." 6 m. Franks, April 7, 1878.

March 23, 1884, I estimated it 6·9 m., one step less than 73 Heis.

No. 410. Lalande 25224 Virginis.—6 m. Lalande; 7 Bessel; 5·7 in DM; 5 Argelander and Heis: 5·3 Gould (at Albany) and 5·9 at Cordoba. Suspected variable by Gould, although included in his "Standards of Magnitude" (*U. A.*, p. 29). 5·60 and 5·4 H.P.

No. 411. Virginis.—One of Pigott's suspected variables. He says (*Phil. Trans.*, 1786):—"This star, which is marked by Riccioli of the 6th magnitude, could not be seen by Maraldi in 1709; nor was it of the 9th magnitude, if at all visible, in 1785." It is not in *Lalande's Catalogue*, or *Harding's Atlas.*

No. 412. 83 Ursæ Majoris.—5-6 Heis. Seen by Birmingham as bright as δ Ursæ Majoris, or 3·7 m., Aug. 6, 1868. Birmingham says:—"It was smaller on the next night, and slowly diminished to its usual magnitude." He calls its colour "fine orange." 4·83 and 5·1 H.P.

Jan. 28, 1878, I found 83 brighter than Alcor (80), and 84 U. Majoris; Jan. 31, 1884, 83 five or six steps brighter than 84, and about seven steps brighter than 81; Feb. 7, 1884, 83, three steps less than Alcor (80).

No. 413. τ Bootis.—A double star, 4·8, 11·4 : 347°8 : 10″·3. 11·4 is a suspected variable. Ward saw it with $4\frac{3}{10}$ inch achromatic, and Sadler found it easy with $6\frac{1}{2}$ in. speculum.

No. 414. ν Centauri.—$3\frac{1}{2}$ m. Lacaille; 3·7 at Cordoba. Dr. Gould suspects variation from 3·3 to 3·7.

No. 415. η Ursæ Majoris.—2·18 Sir J. Herschel (*Cape Obs.*, d. 440) measured 2·01 by Pierce (*Harvard Annals*, vol. ix.). Several observers have suspected a slight variation; 1·75 Pritchard (1882·957).

No. 416. 2 (g) Centauri.—4 m. Lacaille; Sir W. Herschel θ-2; 4·6 Gould. The Cordoba estimates vary from 4·5 to 5·1, and Gould says "show it to be probably variable by about half a unit. The colour appears also to vary, as it has repeatedly been noted as reddish, and on other occasions found without any marked tinge."

No. 417 υ BOOTIS.—4 m. Ptolemy and Sufi; $4\frac{1}{2}$ Lalande; 4-5 Argelander; Sir W. Herschel υ $\overline{,}$ 4; 4-5 Heis; 4·2 Gould; 4-5 Birmingham, April 15, 1872, and 4 m., April 1, 1876. Schonfeld says:—"Rothgelb stark veranderlich in sehr langer Periode mit kleineren Theilen von 50 bis 120 t"; 4 m. Franks, April 7, 1878; 3·91, Pritchard (1882·370).

April 17, 1876, I found it very slightly brighter than τ Bootis.
March 6, 1877, about half a magnitude brighter than τ.
August 1, 1877, about half a mag. brighter than τ.
June 4, 1883, I estimated its mag. at 4·2.
March 22, 1884, estimated 3·6, five steps brighter than τ Bootis (4·10 Pritchard)
April 6, 1884, 3·6.

No. 418. 4632 B.A.C. CANES VENATICI. = LALANDE 25538.—6 m. Lalande; 8 m. Harding; 5-6 Heis; 5 Houzeau (1875·13); 5 Franks: "splendid orange = P Xiii., 136," April 7, 1878. It is not in *Birmingham's Catalogue.* 4·94 H.P.

Feb. 22, 1884, I found it about 4·9 m., and two steps brighter than 25 Can. Venatici.

No. 418*a*. WB Xiii., 830. Dr. Gould says this star, noted by Bessel as 7 m., is now so faint as scarcely to be discernible with the opera glass. Heis gives it (No. 134) as $6\frac{1}{2}^{m}$" (*U. A.* p. 321). It is not given by Lalande or Harding.

No. 419. θ APODIS.—5 m. Lacaille. The Cordoba estimates vary from 5·6 to 6·6. It is a red star. 5 m. *Cape Catalogue,* 1873·39.

No. 420. — VIRGINIS.—Not in *Lalande's Catalogue* or *Harding's Atlas.*

No. 421. — VIRGINIS.—Suspected variable by Professor C. H. F. Peters, from observations at Clinton, U.S.A., in 1879 and 1880 (*Ast. Nach.*, 2360). This star should probably be transferred to Catalogue of Known Variables.

No. 422. θ CENTAURI.—3 m. Lacaille; 2·54 Sir J. Herschel; 3–2 Behrmann; 2·2 Gould. The Cordoba estimates range from 2·2 to 2·7.

No. 423. α DRACONIS.—3-4 Ptolemy, Sufi, Argelander, and Heis; 3 m. Ulugh Beigh; 2 m. Tycho Brahé and Hevelius; 3 m. Groombridge; 3·71 Sir J. Herschel (*Cape Obs.*, p. 440); 3·56 Pritchard (1882·712). Pigott says (*Phil. Trans.*), "I am of Mr. Herschel's opinion that it is highly probable that this star is variable. Bradley, Flamsteed, &c., mark it of the second magnitude; at present it is only of a bright fourth. I have frequently examined it since October, 1782, without perceiving the least change, being constantly rather less

than ι Draconis, equal to δ Ursæ Majoris, and rather brighter than κ Draconis." Smyth (*Bedford Catalogue*, p. 213) says, "I have had it in view many times, and always looking like a small third, though Baron de Zach but shortly before classed it 2·3." 3·63 H.P.

No. 424. — Virginis.—Observed at Markree as 11 m., April 17, 1855; 9 m. on the Paris charts, No. 43, but observed by Palisa only 12·5–13 m., April 2, 1880. It was observed by Peters as 11 m. on several occasions 1870-1880, and he thinks the variability doubtful (*Ast. Nach.*, 2360).

No. 425. Lalande 26031 Virginis.—5 m. Lalande and Harding, 4·8 in D.M. Heis identifies his No. 145 of Virgo with LL 26031, but this seems to be a mistake, the following star (No. 146) being apparently identical with LL 26031. Heis rates this latter star 5–4. The Cordoba estimates vary from 4·8 to 5·5, and Dr. Gould thinks "the discordance is altogether too large to be attributed to errors of observation" (*U. A.*, p. 320). On April 7, 1884, I estimated this star 5·1 m. —one step brighter than LL 26302 (5·2 Gould). 4·97 H.P.

No. 426. 15 Bootis.—5½ Lalande; 6 Harding; 6 Argelander; 6–5 Heis; 5·5 Gould at Albany, and 5·8 at Cordoba; 6 m. Franks (= 14) April 11, 1878 (*private letter*). April 2, 1884, I estimated it 5·7—one step brighter than 18 Bootis; April 6, 5·6.

No. 427. α Bootis (Arcturus).—Sir J. Herschel found it brighter than Capella, April 14, 1838 (*Cape Obs.*, p. 325). Schmidt finds Arcturus variable in colour; 0·34 Pritchard (Oxford), and 0·27 (Cairo) 1883 (Capella being 0·08 and Vega 0·18 on the same scale). 0·03 and 0·3 H.P.

April 3, 1883, I observed Arcturus unusually bright—about half a magnitude brighter than Capella.
April 20, 1883, Arcturus seemed not quite equal to Capella.
April 23, 1883, Arcturus = Capella.
May 16, 1883, Arcturus about 0·2 m. brighter than Vega.
July 27, 1883, Arcturus distinctly superior to Vega, although Vega was at a much higher altitude (9–15 P M).
April 7, 1884, Arcturus about exactly equal to Capella, and of the same colour.

No. 428. W.B. 143 Virginis.—Not in *Lalande's Catalogue*; 6 m. Harding. It is No. 153 of Virgo in *Heis' Catalogue*, where it is rated 6 m.; 7 m. Bessel. The Cordoba estimates vary from 6·0 to 6·6 m.

No. 429. Lacaille 5891 Lupi.—5½ m. Lacaille; 6–5 Behrmann, 5·7 at Cordoba; 5–6 *Cape Catalogue*, 1877·47. Suspected to be variable by Houzeau, who says (*Annals of the Brussels Observatory*), "Le numero 1202 de Lacaille dans la constellation du Loup (No. 5891 du

catalogue réduit aux frais de l'association Brittanique), a été bien vu par moi, comme étoile de 6 me. grandeur, à la date 1875·47. Elle n'avait pas été notée aux dates 1875·10 et 1875·41. Il n'est pas impossible qu'elle soit variable."

No. 430. LALANDE 26211–12 BOOTIS.—6 and 9 m. Lalande; 8 m. Bessel. Not in *Heis's Catalogue*. My observations are:—

May 6, 1877, about 7 m. or perhaps 7·2—less than LL 26182.

June 8, 1877, about the same magnitude.

March 1, 1878, about 7½ m.—less than LL 26229 and LL 26245.

April 21, 1878, 7 m.; March 12, 1880, 7½ m.; about 0·2 m. fainter than LL 26229.

No. 431. υ VIRGINIS.—5 m. Lalande and Harding; 5 Heis, 5 m. in *Durchmusterung*; 6 Piazzi, and d'Agelet. The Cordoba estimates fluctuate from 5·1 to 5·6 (*U. Argentina*, p. 320).

No. 432. LALANDE 26200 VIRGINIS.—6 m. Lalande and Harding; 6·3 in D M; 6 Heis. The Cordoba estimates were 6·5 in 1871, and 6·6 in 1872, but Dr. Gould estimated it 5·9 at Albany (*U.A.*, p. 320).

April 7, 1884, I estimated it 6·2 (equal to LL 26056). 6·11 H.P.

No. 433. 103 VIRGINIS.—7 and 6½ Lalande (υ^2); 7 Harding; 6 Piazzi; 7 Bessel. Not in *Argelander's Uranometria*; 6·7 D M; 6 Heis; 7·2 at Cordoba (1871), and 6·8 (1874).

No. 434. 51 (κ) HYDRÆ.—6 m. Lacaille (5917); 6 and 5½ Lalande; 6–5 Argelander; 6 Heis; 6–5 Behrmann. The Cordoba estimates accord in making it 5·0, and Dr. Gould says, "This star has manifestly grown brighter in recent years." 4·90 H.P.

No. 435. — VIRGINIS.—A nebula discovered by Barnard in 1882, and suspected to be variable, as it is not found in the zones of the Harvard Observatory.

No. 436. BIRMINGHAM 327 BOOTIS.—6 m. Lalande (26325); 6 m. d'Arrest; 7 m. Bessel; 7·3 Argelander. Birmingham's estimates of magnitude, 1872–1876 vary from 6 to 7·5, and he considers the star "strikingly variable in colour," from "no colour" to "reddish." It is 6·7 in the *Uranometria Argentina*, and marked "c" (coloured). April 7, 1884, I estimated it 6·9 m., three steps less than LL 26312, which lies closely to the *north* of it.

No. 437. BIRMINGHAM 328 BOOTIS.—7½ Lalande (26342); 8·0 Argelander. Birmingham's observations, 1872–1876, vary from 7·3 to 9·0.

No. 438. θ BOOTIS.—5–4 Sufi. Not given by Lalande; 3 Harding; 4–3 Argelander; 4 Heis; 4 Franks, April 14, 1878. 4·02 Pritchard (1882·434). Sir W. Herschel found 19 (λ) · 23 (θ) , 21 (ι). 4·25 H.P.

It was measured 4·47 by Pierce (*Harvard Annals*, vol. ix.). He says, "The disagreement of different observers in reference to the relative brightness of θ and λ Bootæ is noticeable. On July 27, 1875, at Munich, I found θ much the brighter." On August 28, 1875, I found θ=κ Bootis, both slightly brighter than ι Bootis; February 19, 1884, I estimated θ two steps brighter than λ, 3½ steps brighter than κ, and six steps brighter than ι Bootis; March 14 θ six steps brighter than κ.

No. 439. *l* (52) Hydræ.—5 and 6 Lalande; 6–5 Argelander and Heis; 5·8 Yarnall; 5–6 Behrmann; 4·8 to 5·0 at Cordoba. 5·01 H.P.

No. 440. ϕ Virginis.—4–5 Sufi; 4½ Lalande; 5 m. Argelander and Heis; 4·8 Gould at Albany; 5·4 in *Uranometria Argentina*, but 4·8 Thome by later observations; 5 m. Franks, April 11, 1878.

No. 441. Birmingham 334 Bootis.—6·2 Argelander. Birmingham's estimates of magnitude 1872–1876 vary from 6 to 7. March 12, 1880, I found it about four and a-half steps less than a star *np* (LL 26634), but brighter than LL 26851; March 15, 1884, six steps brighter than the star *np*, and about 6½ m.

No. 442. Anon Libræ.—Suspected variable by Peters.

No. 443. π Bootis.—5 m. Sufi; 6 Lalande; 4 Harding; 4 Argelander and Heis. Sir W. Herschel gives 35 (*o*), 29 (π); Pritchard 4·10 (1882·370).

July, 1875, I found π about = ξ Bootis (5–4 Heis).
April, 1876, π slightly brighter than ξ.
March, 1877, π slightly brighter than ξ.
March 22, 1884, π one step less than *o*, or 4·6 m.
April 1, 1884, π one step less than *o*, or 4·6; April 6, 4·6.

No. 444. ζ Bootis.—4–3 Sufi; 3, 3½ Lalande; 3 Harding; 3·4 Argelander and Heis; 3½ Franks, April 11, 1878; 3·38 Pritchard (1882·370). It is a close double star (Doberck 299°.8 : 1″, 1877). Smyth says (*Bedford Catalogue*, p. 324): "B, 4½, bluish white, and supposed to be variable." Struve and Secchi considered the components to be alternately variable. 3·84 and 3·9 H.P.

No. 445. U Bootis. Considered to be variable by Baxendell, but rejected by Schönfeld.

No. 446. 31 Bootis.—5 m. Lalande, Harding, and Heis; 4·8 Gould (at Albany); 5·4 at Cordoba; 5–4Argelander; 5½ Franks (=P xiv. 73), April 11, 1878. Sir W. Herschel gives 35 (*o*)—31–32.

Closely *s.f.* is a 9 m. star, Lalande 26786.

April 6, 1884, I estimated it 5·0—two steps brighter than LL 26302, but slightly less than 110 Virginis.

No. 447. 34 BOOTIS.—5 Lalande (26853); 5 Harding; 5 Heis. Sir W. Herschel gives 34- - 26. 5·03 Pritchard (ϵ^2) (1882·449). It is included by Schönfeld in his provisional list. He says (quoting Schmidt), "Merklich veränderlich in längerer Periode aber wegen der Nähe von ε Bootis sehr schwer zu beobachtungen, AN 72·1713."

(May 25, 1875, I found 34 barely visible to the naked eye in the Punjaub.)

Schmidt deduces a period of 361 days, with a maximum on February 24, 1876, and remarkable anomalies in the light curve.

March 21, 1884, I estimated it 4·8 m.—one step less than ω Bootis.

No. 448. ε BOOTIS.—3 m. Sufi and Lalande; 2–3 Argelander and Heis; 2·80 Sir J. Herschel; 3 Franks, April 11, 1878; 2·47 Pritchard (1882·449). Baxendell says he has no doubt of the variability of this star, as he finds it sometimes almost exactly equal to α Coronæ, and at others about seven or eight-tenths of a magnitude fainter (*English Mechanic*, May 18, 1883). His observations, however, indicate slight fluctuations in α Coronæ. ε is 2·56 in H.P.

May 25, 1875 I found ε Bootis brighter than δ, and about equal to α Coronæ.

May 2, 1877, α Serpentis and ε Bootis almost exactly equal, and of the same colour.

April 6, 1884, ε Bootis about six steps less than α Coronæ, but three steps brighter than η Bootis (moonlight).

No. 449. LACAILLE 6082 CENTAURI.—5, 6, and 6½ Lacaille; 6 Behrmann. Probably variable according to Gould from 6·0 to 7·0 (*U. A.*, p. 259).

No. 450. LALANDE 26980 BOOTIS.—6 m. Lalande; 7½ Bessel; 7·5 in D.M.; 6 Argelander; 6–7 Heis; and 6·8 at Cordoba. Dr. Gould suspects variation, although the star is included in his "Standards of Magnitude" (*U. A.*, p. 29). 6·61 and 6·3 H.P.

No. 451. LALANDE 27017 BOOTIS.—7 m Lalande and Harding; 7½ Lamont; 7·5 in DM; 6 m. Argelander and Heis; 7·0 Gould, who considers it probably variable (*U. A.*, p. 339).

No. 452. LACAILLE 6077 APODIS.—6 m. Lacaille; 5–6 *Cape Catalogue*, 1873·52). The Cordoba estimates vary from 5·5 to 6·2. It is a red star.

No. 453. LALANDE 27095 BOOTIS.—7 m. Lalande. Not in *Harding's Atlas*. Missed by Bode (March, 1804), who says, "Ist nicht mehr am Himmel zu finden." Observed by Bessel as 9 m. May, 1828; 9 m. Argelander, 1866. It lies closely *nf* Lalande 27083 (= 4906 BAC = 98 Heis, Bootis (6 m.). March 15, 1884, not seen with binocular.

No. 454. Lacaille 6137 Centauri.—Dr. Gould suspects variation of about half a magnitude in this star, and also in another star *s f*, Lalande 6146 (R A 14^h 48^m 23^s, S 33° 22′·1) (*U. A.*, p. 269).

No. 455. *β* Ursæ Minoris.—2 m. Ptolemy, Sufi, Argelander, and Heis; Franks "bright 3 m.," April 14, 1878 (*private Letter*); 2·26 Pritchard (1882·363). Found to be variable from 2·2 to 2·8 by Espin from observations in 1881 and 1882. He deduces a period of 10·6747 days with epoch of maximum, April 1882, 4^d·10 (*Mon. Not.*, *R.A.S.*, April 1882). The star's magnitude for the greater part of its period is 2·5 or 2·6. The minimum takes place two or three days before the maximum. Observations confirmed by Read. In the *Cape Observations* (p. 350) Sir J. Herschel gives observations on this star, and concludes that it is certainly variable. He suggests a period of over ten years. 2·13 and 2·0 H.P.

No. 456. Lacaille 6198 Lupi.—7 m. Lacaille; 5 m. Harding; not given by Behrmann; variously estimated at Cordoba from 5·5 to 6·5 (?) (*U. A.*, p. 277).

No. 457. Lalande 27307–8 Bootis.—7 and 9½ Lalande; 7 Harding. My observations are:—

March 4, 1878, about 7½—equal to a star *n p*, but less than a star *s p*.

March 12, 1880, 7½—equal to the star *n p*, but less than the stars *p*; 7½—equal to the star *n p*.

No. 458. 20 Libræ (= *γ* Scorpii, Heis).—3–4 Sufi, Argelander, and Heis; 3 Houzeau (1875·10); 4–3 Behrmann; 3·5 Gould. Sir J. Herschel estimated it 3·98 (*Cape Obs.*, p. 343); 5 m. Franks, "fine orange," April 8, 1878; 3–4 *Cape Catalogue* (1878·41). Dr. Gould calls it *σ* Libræ. 3·25 H.P.

No. 458a. 44 Bootis.—5 m. Lalande; 5–4 Heis; 5·03 Pierce; 4·65 Pritchard (1882·452). A binary star, 5, 6: 238°: 5″, 1877. Webb says (*Cel. Obs.*, p. 244), "Struve and Argelander have found variable light here." 4·90 and 4·8 H.P.

No. 459. 47 (*κ*) Bootis.—4·9 Argelander; 5·4 D M; 5–6 Heis; 6·02 Pierce; 5½ Franks (very little < 44) April 21, 1878 (*private Letter*). Pierce suspects variation. He says (*Harvard Annals*, vol. ix.), "Argelander makes this star 4·9; I, 6·0. Sir William Herschel makes it equal to 39; the D M 0·2 brighter; Heis 0·6 brighter; Argelander 0·9 brighter; and I, 0·1 fainter. July 27, 1875, at Munich, I inclined to think it brighter than 39. April 7, 1876, at Berlin, I found it a little brighter than 39, and made its magnitude, by comparison with 39, *h* and 134 Heis, to be 5·75." 5·57 and 5·3 H.P.

Sir W. Herschel gives 44 , 47·39 and 47–40.

March 4, 1883, I found 47 much inferior to 44; 47 about three steps brighter than a 6 m. star closely *s p* 44; 47 about = 39.

From this observation I would estimate the magnitude of 47 to be about 5·6 on the above date. Sir W. Herschel's sequence compared with the above observation seems to point to 44 as the probable variable. February 24, 1884, 47 considerably less than 44, but three steps brighter than 39.

No. 460. δ BOOTIS.—4–3 Ptolemy, and Sufi; 3 m. Lalande, Harding, Argelander, and Heis; 3·1 Gould (1858); 3·5 Chandler; 3·44 Pritchard (1882·452). Dr. Gould states (*A.N.*, 1620) that "Mr. Chandler is confident that he has seen δ Bootis vary." Heis's *Observations*, 1844-1849 show δ from one to four steps fainter than β. Franks found it a "bright 4 m., but scarcely 3½ m" April 21, 1878 (*private Letter*). Sir W. Herschel gives 27 (γ) — , 49 (δ) 42 (β) — , 49 and γ – – 49.

March 23, 1884, I estimated it 3·5—one step less than β.

No. 461. STRUVE 1932 CORONÆ BOREALIS.—A double star 5·6, 6·1 : 299°·3 : 0″·96 (1875). Struve suspected the comes of variation. This star is not in *Heis' Catalogue.* It seems to be LL 27943 (6 m.).

March 7, 1884, below 6 m.; March 21, 1884, I estimated it 6·8.

No. 462. LACAILLE 6320 LUPI.—7 m. Lacaille. Taylor suspected variation, and Gould confirms the suspicion, the Cordoba estimates varying from 6·8 to 7½.

No. 463. δ LUPI.—3½ Lacaille; 3·7 at Cordoba. Dr. Gould suspects variation in this star from 3·4 to 3·7.

No. 464. LACAILLE 6308 TRIANGULI AUSTRALIS— 6-5 *Cape Catalogue* (1874·46). A comparison star for the variable R. Trianguli Australis. According to the Cordoba estimates it varies between 6·4 and 6·8 (*U. A.*, p. 261).

No. 465.–TRIANGULI AUSTRALIS.—A comparison star for R. Trianguli Australis. It seems to vary from 7·0 to 7·8 from observations at Cordoba.

No. 466. ϵ LIBRAE.—4 m. Lalande, Harding, Tycho Brahé, and Hevelius; 5 Heis; 5½ m. *Armagh Catalogue*; 5·3 *Radcliffe Catalogue* (1860); 5·5 Gould; 5½ Franks, April 15, 1878. On May 5, 1875, and 23 May, 1876, I found ϵ fainter than 37 Libræ (5 Heis) 5·15 H.P.

No. 467. LACAILLE, 6417 LUPI.—7 m. Lacaille. Missed at Cordoba in June and July, 1875. Observed in 1876, as 8 m., June 27, and below 9½, Aug. 5; afterwards found a little below 7·0.

No. 468. LACAILLE 6439 LUPI.—7 m. Lacaille; 5·8 Yarnall, 1862. Its brightness varies, according to Gould, through half a magnitude (*U. A.*, p. 278).

No. 469. γ LIBRAE.—4 m. Sufi and Ulugh Beigh; 3 Tycho Brahé; 6 m. Hevelius; 3½, 4 Lalande; 4-5 Argelander and Heis; 4½ *Armagh Catalogue*; 4·3 *Radcliffe Catalogues* (1845 and 1860); 4·4 Gould; 4·01 H.P.

No. 470.—δ SERPENTIS.—A double star, 3, 5 : 190°: 3″·5, 1876. One of the components suspected of variation. It was rated 3-4 by Sufi; 4½ and 3 by Lalande; 3-4 by Argelander and Heis; 3·80 Pritchard (1882·467.) 3·96 H.P.

No. 471. α CORONÆ BOREALIS.—2 m. Sufi, Piazzi, and Harding, Argelander and Heis; 2, 2½, and 1 m Lalande; 2·69 Sir J. Herschel (*Cape Obs.*, p. 440); 2·23 Pritchard (1883·201) Baxendell thinks that his observations "indicate that the light of α Coronæ is subject to slight fluctuations" (*English Mechanic*, May 18, 1883). Sir W. Herschel gives 5 (α)—36 Bootis (ϵ). 2·37 H.P.

April 6, 1884, I estimated α Coronæ about six steps brighter than ϵ Bootis.

No. 472. μ CORONÆ BOREALIS.—5 m. Lalande, Harding, and Heis; 6 m. Franks, 1878. Sir W. Herschel gives 11 (κ)—6 (μ), 9 (π).

April 6, 1884, I found μ less than κ Coronæ, but brighter than ϕ Bootis.

No. 473. τ^4 SERPENTIS = BIRMINGHAM, 356.—6 m. Lalande (28448) 7·5 d'Arrest; 6 Bessel. Birmingham's observations 1872-76, vary; from 6 m. to invisibility. 6·89 and 6·1 H.P.

April 21, 1878, I found this star 7 or 7-8 m. About equal to, or slightly brighter than a star *s.* of it (LL, 28460, rated 6 m. by Hencke); 23rd Sept, 1878, with 3-in. achromatic, τ^4 reddish orange, and about half a magnitude brighter than the star *s.* of it; May 1, 1883, about two steps less than the star *s.* of it (with binocular).

No. 474. STRUVE 1964 CORONÆ BOREALIS.—A double star, 6·8, 7·3 : 86°·1 : 15″·4. Webb suspects 6·8 of variation. It seems to be Lalande 28568 and 28570 (both 8½)

No. 475. LALANDE 28590 LIBRÆ (= Σ 1966).—9 m. Lalande. Suspected variable by Struve, and the suspicion confirmed by Weiss, 1879.

No. 476. LALANDE 28607 LIBRÆ.—7 m. Lalande. Said to be variable by Weiss, from 7·0 to 8·8 in a period of about 4 months. The star has a considerable proper motion.

No. 477. α SERPENTIS.—A wide double star, 2·5, 15 : 354°·5 : 58″.9, 1878. Smyth calls the *comes* an "extremely delicate object." Webb suspects it of variation. He found it "obvious with 9⅓-in. speculum," 1867, and Sadler saw it with 2½-inch achromatic, 1874. Burnham gives it 12m. (1879·304).

No. 478. LACAILLE 6514 LUPI.—6m. Lacaille. Gould says: "There is small room for doubt that the magnitude of this star varies from near 5½ m. to 6½ m.; but there are not yet sufficient data to fix the limits or period" (*U. A.* p. 278.)

No. 479. LALANDE 28716 SERPENTIS.—6 m. Lalande; 6·7 Heis. Not in Argelander's *Uranometria;* 6·1 Gould. My suspicion of variability rests on my own observations, which are as follows:—

Sept., 1877, Lalande 28716 equal to λ Serpentis (4-5 Heis).

April 21, 1878, distinctly less than λ.

April 5, 1883, More than a magnitude less than λ. About three steps brighter than 40 (6-7 Heis), or about 6·1 m.

April 20, 1883. Seems a little less than 6 m., or abont 6·2.

April 30, 1883. About 6 m.—visible to naked eye.

Possibly, however, λ may be the variable—perhaps of the Algol type.

No. 479*a*.—LIBRÆ.—See *Ast. Nach.*, No. 2434.

No. 480. ANON CORONÆ BOREALIS.—Included by Schönfeld in his provisional list. He says, "Vergleichstern zu R. Coronæ, schwankt nach Schmidt zwischen 11 m. und 13·12 m. AN 80·1912 Meine Beobachtungen geben gleichfalls eine schwache Veränderlichkeit in engeren Grenzen." Schmidt found a period of 1½ to 2 months.

No. 481. 5248 B.A.C. DRACONIS.—In *Comptes Rendus*, vol. xxvii. p. 113, are the following remarks with reference to this star: "*p* by a star yellow − $1^m\ 0^s{\cdot}73$ and 5′53″·2 further *n*. Both visible to the naked eye; but Argelander in *Uranometria Nova* only shows the yellow star. In Argelander's zone observations 5248 is 5 m., and the yellow 6 m. Both were observed at Oxford in June, 1845. No magnitude is given to 5248, but the yellow observed 3 times of 6·7 and once 7 m.; whereas M. Butillon's repeated observations makes its magnitude 5½." 5 m. Heis; 6 m. Franks, April 21, 1878 (*private letter*). My observations are as follows:—

November 24, 1878. About ½ a magnitude brighter than the star to the *north*, but nearly one magnitude less than a star *sf* (5 m. Heis); October 5, 1879. About the same as above; April 8, 1883. About one step brighter than the star to the *n*, and about equal to a 6 m. (Heis) *nf*.

No. 482. LACAILLE 6546 NORMÆ (*Uranometria Argentina*, p. 269).

No. 483. ρ SERPENTIS.—4 m. Lalande; 5 Harding; 5 Heis; 5½ Franks, 1878. I found it brighter than Lalande 28993 (5½ m.) April 21, 1878; also brighter than 26 Serpentis (6 m. Heis).

No. 484. LACAILLE 6536 APODIS.—7 m. Lacaille. The Cordoba estimates show fluctuations of brightness from 6·7 to 7·4, or perhaps through a greater range (*U. A.*, p. 243).

No. 485. 39 SERPENTIS.—Smyth says (*Bedford Catalogue*, p. 350), "39 Serpentis has been suspected of variability, and was even mistaken for Harding's variable star, which is 2° north of it." He gives its magnitude as 7½ (after Piazzi); but Heis saw it with the naked eye, and rated it 6–7. It is not in Argelander's *Uranometria*. It is 7 m. in *Lalande's Catalogue* (28935).

No. 486. ζ URSÆ MINORIS.—4 m. Ptolemy and Sufi; 4–5 Argelander and Heis; 4·65 Pritchard (1882·708). Espin finds variation from 4·2 to 4·7. 4·49 H.P.

No. 487. LACAILLE 6578 TRIANGULI AUSTRALIS.—Dr. Gould thinks this star certainly variable, and reserves for it the designation S. Trianguli Australis, to be assigned to it when its changes "have been fully demonstrated" (*U. A.*, p. 260).

No. 488. D.M. 26°, 2760 CORONÆ.—9·1 in *Durchmusterung*. Dr. Gould says (*A. N.*, 1620) "the variation of another of our comparison stars. (for T. Coronæ) Argel. *Durchmusterung* 26°, 2760, is, I think, beyond reasonable doubt." He estimated its magnitude 8·9.

No. 489. β SCORPII.—3 m. Sufi; 2 Argelandar and Heis; 2·96 Sir J. Herschel; 2·5 at Cordoba ("dpl. 2½, 7¾"); 3 m. Franks, April 12, 1878 (*private letter*). Suspected variable by Kirch in 1704. He found changes in the relative brightness of β and δ Scorpii; sometimes β and sometimes δ being the brighter (*Nature*, December 30, 1880).

It is a double star (2, 5·5 : 24°·9 : 13″·1), and Smyth says (*Bedford Catalogue*, p. 353), "the two point nearly to a 5th magnitude star in the *nf* quadrant." With reference to these companions, Powell remarks:—"It would appear that a variation has occurred in the relative brilliancy of A, B and C. The Cycle arranges them thus:—

$$A = 2,\ B = 5\tfrac{1}{2},\ \text{and}\ C = 5;$$

while I rank them A = 2½, B = 5, and C = 7."

Powell gives for C, P = 31°·08, D = 520″·4. Dr. Gould gives 2¼, and 7¾ (*Uranometria Argentina*, p. 175). 2·91 H.P.

August 10, 1876. I found β and δ almost exactly equal; perhaps δ *very* slightly the brighter of the two; both slightly superior to π Scorpii (3 m. Heis); β and δ seem nearer 3 m. than 2 m.

August 22, 1876. β Scorpii, a little less than η Ophiucii (2–3 Heis), and about equal to ζ Ophiucii (3–2 Heis).

August 6, 1877. β Scorpii slightly less than δ.

No. 490. 67 HEIS DRACONIS.—6–7 Heis, and identified by him with No. 1801 of *Argelander's Catalogue of Stars*, between –2° and + 90° declination. I found this star only 8½ m., November 24, 1878, and April 8, 1883. It lies a few minutes *following* 5248 B.A.C. (No. 481 of this Catalogue). If it was ever visible to the naked eye, it must certainly be variable. It is not in *Argelander's Uranometria*.

No. 491. 5341, B.A.C. DRACONIS.—6 m. Harding; 6–7 Heis; 6½ Franks, 1878. It seems to be Lalande, 29351 (6 m.) . On February 24, 1884, I estimated it 6·6 m. 6·24 H.P.

No. 492. LALANDE 29344-5 SCORPII.—5½ and 10 Lalande; 6½ Lacaille (6710); 6 Harding; 6·3 Gould; 6–7 *Cape Catalogue* (1878·59).

May 6, 1875, I found this star about 7 m.

May, 1877, I estimated it 6·3 m.

No. 493. κ HERCULIS.—4 m. Ptolemy; 4–5 Sufi; 6 Lalande (29427). 6 Harding; 5 Argelander; 5–6 Heis; 5. Franks, April 7, 1878.

Sir W. Herschel gives 7 (κ) – – 5. 4·81 H.P.

April 21, 1878, I found it brighter than Lalande 29273.

May 16, 1883, κ Herculis about 3 steps less than ω Herculis, but brighter than 5 Herculis.

No. 494. BIRMINGHAM 372 SERPENTIS.—7 m. Lalande (29441); 7 Bessel; 7·0 Argelander. Birmingham's Observations of Magnitude (1874–1876) vary from 6 to 7·5. It also seems to vary in colour. It is not in the *Uranometria Argentina.*

No. 495.—SCORPII. Observed 11 m. at Markree, April 17, 1855; 9 m. in the Paris charts, but seen only 12·5–13 m. by Palisa, April 2, 1880. Peters, however, thinks that further observations of this star will be necessary before its variability can be considered as established (A. N. 2360). This seems to be identical with No. 114 of *Catalogue of Known Variables* (V. Scorpii).

No. 496. 12 SCORPII.—6 m. Lacaille and Piazzi; 7 m. in *Argelander's Zones*; 6 m. Yarnell, 1856; 6 m. Ellery, 1861, and 7 m. 1864. The Cordoba estimates vary only from 6·0 to 6·3; but Dr. Gould considers its variability probable (*U. Argentina*, p. 284). He calls it "red." July 6, 1877, I found this star less than Lacaille 6725 (5·8 Gould).

No. 497. – HERCULIS.—A star considered by Dr. Schmidt to be probably variable. The position given is only approximate.

No. 498. W. B. 140 SCORPII.—6 m. Heis. Not in *Argelander's Uranometria*; 6 m. in Harding's Atlas. Dr. Gould says, "this evidently varies through at least the greater part of a magnitude." (*U. A.*, p. 284). His average magnitude is 6·3.

No. 498A. σ CORONÆ.—A small star following this Binary (51″, 1862) was rated only 15 or 20 m. by South in 1825, but "more like 10 m." by Franks, 1876 (*Cel. Obj.* p. 283). I have seen this small star well with 3-inch refractor in the Punjab sky.

No. 499. LACAILLE 6783 NORMÆ.—6 m. Lacaille; 6–5 Behrmann; 6–7 *Cape Catalogue* (1875·54). The Cordoba Observations vary from 6·9 to 7·3, and Gould thinks it "not improbably variable."

No. 500. LALANDE 29822 OPHIUCHI.—Rated 7 m. by Lalande and Harding; 7·0 in D.M.; 7·3 at Cordoba; but given by Heis as 6–7 (*U. A.*, p. 307).

No. 501. χ OPHIUCHI.—6 m. Argelander and Heis ($\psi = 5$ m.). Dr. Gould suspects variation; the Cordoba estimates varying from 4·3 to 4·7. Franks found "ψ inferior to χ," and $\chi = \phi$ Ophiucii, April 27, 1878. On May 5, 1875, I found χ equal to ϕ Ophiucii, and slightly brighter than ψ.

No. 502. BIRMINGHAM 379 OPHIUCHI.—Birmingham's Observations, 1873–1876, vary from 7·5 to 9–9·5.

No. 503. α SCORPII (Antares).—2 m. Ptolemy and Sufi, 1–2 m. Argelander and Heis; 1·4 Gould. Secchi observed some change in its spectrum, and found it "June 22, 1870, small, scarcely 2 magnitude; colour rather yellow than red" (Notes to *Birmingham's Catalogue*, p. 320). 1·06 and 0·7 H.P.

No. 504. η DRACONIS.—A double star (O Σ 312). 2·9, 9·0: 141°·7: 5″·26 (Burnham, 1878). "Rogers suspects variability in the small star." (*R. A. S. Memoirs*, vol. xliv. p. 270). Burnham gives the companion 10·5 m. (1879·274. *R. A. S. Memoirs*, vol. xlvii. p. 290).

No. 505. β HERCULIS.—3 m. Sufi, Ulugh Beigh, Tycho Brahé, Hevelius, and Lalande; 2–3 Argelander and Heis; 2·67 Pritchard (1882·387). Sir W. Herschel says (*Phil. Trans.*, 1796), "by my own observations the light of this star seems to be subject to change. Flamsteed's observations give it twice 3 m., and once 2 m." He found it sometimes less, and sometimes brighter than ζ Herculis, which he also suspected of variation.

No. 506. 29 HERCULIS.—5½ Lalande (30111); 4·8 Peirce (reduction of Sir W. Herschel's estimates, *Harvard Annals*, vol ix); 5–6 Heis. Sir W. Herschel says (*Phil. Trans.*, 1796), "very possibly this star may be changeable." 5·00 H.P.

No. 507. H. SCORPII = LACAILLE 6890. —5 m. Lacaille; 5–6 Behrmann; 4–3 Yarnall, 1863; 5–6 *Cape Catalogue* (1877·91). Gould thinks it probably variable between the limits 4½ and 5.

No. 508. 33 HERCULIS.—7 m. Lalande (30229); 6m. Harding. Not in *Heis' Catalogue;* 7 m. Franks, April 27, 1878. Sir W. Herschel gives 41, 33. The star is not in the *Uranometria Argentina*, so must have been seen below 7 m. at Cordoba.

April 26, 1878, I found 33 Herculis fainter than 41, and equal to Lalande 30439 (7½ m.).

No. 509. 17 DRACONIS.—5½ Lalande (30366); 5 Harding; 16 and 17 Draconis are together rated 4–5 by Heis. It is a double star, 6, 6·5 : 115°·7 : 3″·8, Struve, who considers the components alternately variable. Pritchard gives 17 Draconis = 5·22, and 16 = 5·07 (1882·717).

No. 510. BIRMINGHAM 391 OPHIUCHI.—Birmingham's observations. 1872–1876, vary from 9 m. to invisibility in his 4½-inch telescope. The colour also seemed to vary.

No. 511. ι OPHIUCHI.—4 m. Sufi; 4½ Lalande and Bessel; 4·1 DM; 4–5 Argelander and Heis; 4·4 Gould (at Albany), and 5·0 at Cordoba. Gould suspects variation, although the star is included in his Standards of Magnitude (*U.A.*, p. 30); 4·12 Pritchard (1882·475).

No. 512. - SCORPII.—A star believed by Gould to be variable. It was observed on the meridian at Cordoba as 6½ m., 1874, August 24; but seen only 8½ m., 1873, Aug. 11 and 19. It lies closely *np* 12 Scorpii (*U.A.*, p. 286).

No. 513. 24 OPHIUCHI = Lalande 30756.—6 m. Lalande and Harding. Not given by Heis, Behrmann, or Houzeau; 5·9 Gould; 5½ Franks; "white," April 27, 1878; 7–6 *Cape Catalogue* (1879·26).

No. 514. LACAILLE 7057 ARÆ.—6½ Lacaille; 6 Brisbane; 7 Taylor; 7–6 *Cape Catalogue* (1875·57). Gould suspects variation, and says "numerous estimates of the magnitude vary from 6·5 to 7·3."

No. 515. 30 OPHIUCHI (= Lalande 30924).—5½ m. Lalande; 5 Harding, Argelander, and Heis; 5·8 Yarnall. The Cordoba estimates vary from 5·1 to 5·9. It is Birm. 399 ("yellow orange").

No. 516. 20 DRACONIS.—A close double star 7, 7½ : 243°·7 : 0″·7 (1839); Burnham 213°·7 : 0″·20 (1880). Admiral Smyth remarks (*Bedford Catalogue*, p. 379), "he (Sir W. Herschel) says the components of this object were considerably unequal, whereas they are now so nearly of the same magnitude, that it was only after much comparison that I felt inclined to place the *comes* in the *sp* quadrant. Can it be variable?"

No. 517. 5749 B.A.C. HERCULIS = 32 Ophiucii.—5 m. Lalande (31037); 5 m. Argelander; 6–7 Houzeau (1875·29); 6 m. Franks; "pale orange," April 27, 1878. 5·11 H.P.

No. 518. μ DRACONIS.—4 m. Ptolemy, Tycho Brahé and Hevelius; 5 m. Sufi; 5 Ulugh Beigh; 4 and 5 m. Harding; 5 Groombridge; 4 Piazzi; 5–4 Argelander and Heis; 6 m. Houzeau. Sir W. Herschel gives μ. *g* and 30, μ; 5 m. Franks, May 3, 1878 (*private letter*); 5·00 Pritchard (1882·717). This star is probably variable, as pointed out by the Rev. S. J. Johnson and M. Flammarion. I have several times observed it to be rather below than above 5 m., and have never seen it anything approaching in lustre a 4 m. star. April 2, 1884, I found μ two steps brighter than 30 Draconis (5 m. Heis).

No. 519. LACAILLE 7171 SCORPII.—7 m. Lacaille; 7 m. Yarnall (1869). The Cordoba estimates vary from 6½ to below (?) 7 m. (*U.A.*, p. 286).

No. 520.—No. 282 of *Burnham's Fifth Catalogue of New Double Stars*. Suspected to be variable by Burnham, as it is not found in the catalogues of Weiss, Lalande, Rumker, Schjellurup, Bode, and others. It was estimated 7 m. by Burnham, and twice 6·5, and once 7 m. by Dembowski. In one of *Lamont's Catalogues* it is rated 5 m. (*Ast. Register*, August, 1876). In the *Berlin Star Charts* it is 7 m. It is 6 m. in *Harding's Atlas*, but is not given by Heis. In the *Uranometria Argentina* it is 6·3 m. (No. 105 of *Ophiucus*). September 8, 1876, I found the star about 6½ m., and equal to Lalande 31289; *just* visible to the naked eye on a very clear night in the Punjab.

Franks estimated it 6 m., May 3, 1878. In 1880 Burnham gives it 5·5 m. (*Memoirs R.A.S.*, vol. xlvii., p. 293).

No. 521. ι APODIS (= Lacaille 7156).—5½ Lacaille; 6 and 5¼ Ellery; 5–4 Behrmann. From the observations at Cordoba, which range from 5·1 to 6·0, Gould considers that this star is variable to the extent of about a maguitude. 6 m. *Cape Catalogue* (1877·51).

No. 522. 69 (*e*) HERCULIS.—5 m. Sufi; 5 Ulugh Beigh; 4 m. Tycho Brahé; 4½ Hevelius; 5–4 Heis; 5 Argelander. Sir William Herschel found it less than 76 (λ), and gives the sequences 94, 69–99 and 69–68; 5 m. Franks, May 3, 1878; 4·52 Pritchard (1882·376). It was considered to be variable by H. T. Vivian in 1870; he found variation from a large 5 m. to a small 6 m., with a period of about 21 days (*Ast. Register*, 1870, p. 275). 4·94 and 4·8 H.P.

June 6, 1875, I found 69 fainter than ρ Herculis.

May 14, 1883, I estimated it 4·7, from comparisons with ρ and 59 Herculis.

No. 523. LACAILLE 7267 ARÆ.—6 m. Lacaille. Gould remarks with reference to this star:—"The determinations for this object are unusually discordant, suggesting the probable variability of one of the three stars whose joint light is estimated.

No. 524. 44 (*b*) OPHIUCII.—5 m. Lacaille (1752); 5 Mayer (1756); 4·5 Piazzi (1794); 5 Lalande; 5·5 Taylor (1833); 5 m. Argelander; 5·0 Gilliss (1847); 6·2 Argelander (1849); 5·5 Johnson (1853); and 4·7 in 1858; 3·6 Newcomb, June 1862, and 4·2 July 1862; 5·0 Heis; 5-6 Behrmann; 4·5 Gould; 4½ Franks, April 30, 1878 (> 51 Ophiucii = ξ Oph.) (*private letter*); 5½ *Cape Catalogue*, 1880; August 6, 1877, I found 44 brighter than 51 Ophiucii (5 m. Heis). 4·47 H.P.

No. 525. LALANDE 31727 OPHIUCII (Hevelius 27); 5 m. Hevelius and Lalande; 6 m. Harding; 5–4 Argelander and Heis; 4·6 Gould (at Albany), and 4·5 to 5·1 at Cordoba (*Uranometria Argentina*, p. 307). 4·68 at Oxford (1882·475); 4·62 H.P.

No. 526. σ OPHIUCHI.—6 m. Sufi; 4 Harding; 4·0 DM; 5 m. Argelander; 4–5 Heis; 4·5 Gould (at Albany), and 4·7 at Cordoba, 4·45 Pritchard (1882·483). Dr. Gould suspects variation, although he includes it in his "Standards of Magnitudes" (*U. A.*, p. 31).

No. 527. 51 OPHIUCHI (*c*).—5½, 5 Lalande (31824–5); 6 Lacaille; 5 Heis; 5–6 Behrmann; 5 Franks, April 30, 1878; 6–5 *Cape Catalogue* (1878·60). The Cordoba estimates vary from 4·8 to 5·6, "diminishing steadily from 1871 to 1874."

No. 528 – ARÆ.—Estimated 5 m. by Tebbutt in 1862, while observing Comet III. of that year. It was about "a degree north-east" of σ Aræ, and both stars were visible to the naked eye, the supposed variable being the brighter of the two. On examining the place of the star with a 4½-inch refractor, on November 13, 1877, Tebbutt only found stars of the 10th and 11th magnitudes near the spot. One faint star particularly attracted his attention, and its position agreed fairly well with that of the 5 m. star observed in 1862. There are some other faint stars near the place (*Mon. Not.*, R.A.S., March, 1878).

No. 529. BIRMINGHAM 418 SERPENTIS.—8·5 Argelander. Birmingham's estimates of magnitude, 1873–1876 vary from 7·5 to invisibility.

No. 530. SAGITTARII.—A star 7 m. in *Harding* and *Diens' Atlas*. Not in *Lacaille's Catalogue*. I could not see this star with the binocular in the Punjab on July 28, 1877, and August 3, 1877. It lies closely north of Lacaille 7451 (5½) (5·5 Gould).

No. 531. 88 (*z*) HERCULIS.—7½ and 8 Lalande (32758 and 32760) 6 m. Heis. Sir W. Herschel gives 74·88. Pierce says, "I am confident that this star is variable. It is now of the 7th magnitude, and very considerably fainter than 120 Heis or 148 Heis, which Heis and the DM call 6·3, but which are, in fact, hardly brighter than 6·6. Yet the star was seen by Ptolemy, who makes it 5·6, in which he is supported by Sûfi and Ulugh Beigh. Tycho and Hevelius called it a nebula. William Herschel makes it 5·9; Argelander and Heis 5·8; the DM 6·4, and I, 6·9. William Herschel makes *z* 0·2 fainter than *y*; Argelander makes them equal; Heis makes *z* 0·4 fainter; the DM, 0·6 fainter; and I, 1·3 fainter. April 6, 1876, I find that my magnitudes of stars in this vicinity continue to represent them very well."

November 14, 1878. *z* (88) considerably less than 82 (*y*) Herculis; *z* certainly less than 6 m. February 22, 1884, 88 about equal to 169 Heis, but much less than 82 (*y*); seems not above 6½ m: March 23, 1884, 88 = 169 Heis, or 6·5 m. 6·37 and 6·2 H.P.

No. 532. BIRMINGHAM 420 OPHIUCHI.—Birmingham's observations, 1871 to 1876, vary from 7–8 to invisibility. He says "it is certainly

variable." Webb also suspects variation, and failed to see the star on two occasions, August 7, 1871, and September 22, 1873; May 2, 1878, not seen with binocular.

No. 533. LALANDE 32847 SAGITTARII.—7½ Lalande; 6–7 Heis; 7¾ Gould (*U. A.*, p. 291).

No. 534. BIRMINGHAM 422 OPHIUCII.—7 m. Bessel. Birmingham's observations, 1872–1876, vary from 7 to 8·5. It lies *s.p.* 67 Ophiucii (4m. Heis).

No. 535. 65 OPHIUCII.—This star is supposed to have disappeared, as it was duly observed by Flamsteed, on May 6, 1691, at 14^h 10^m 58^s, and the observation regularly reduced by him. No such star is now to be found. It was looked for at Greenwich, but without success. There is no star in the position in Argelander's Southern Zones, nor in the Washington Zones. It has been suggested that Flamsteed may have observed a so-called "temporary star" (*Nature*, March 15, 1877).

The star is not in *Lalande's Catalogue* or *Harding's Atlas*.

No. 536. DM 45°, 2627 HERCULIS (= LALANDE 33006–7).—6 and 4½ m. Lalande; 6·1 DM; 6·21 Pierce, who says (*Harvard College Annals*, vol. ix., p. 141), "I believe this star to be variable. I found it the brightest of the group except 182 Heis Herculis, and yet neither the *Uranometria* nor Heis has it. My measures show some discrepancies, even rejecting that of set (19), which is affected by a large colour correction. The star is remarkably ruddy." It is not in *Birmingham's Catalogue of Red Stars*.

March 23, 1884. I estimated it 6·9—three steps less than 179 Heis.

No. 537. 68 OPHIUCII.—5½ Lalande (33027); 4–5 Argelander; 5–4 Heis. Rated 4·4 in the Albany observations by Gould, but only 5·1 at Cordoba. Gould suspects variation, although he includes it among his "Standards of Magnitude" (*U. A.*, p. 31).

October 21. 1876. I found 68 equal to 70 Ophiucii (4·2 Gould).

No. 538. π PAVONIS.—4 m. Lacaille (7527); 4·5 Behrmann. In the *Paramatta Catalogue* there is a remark with reference to this star. "The observer suspects this star variable." In the *Cape Catalogue* (1880) Stone remarks, "This star is probably variable. It was observed in 1871, and again in August 25, 1875, when it was noted as of the sixth magnitude." Dr. Gould, however, says, "Not the least variation from the magnitude 4·6 has been observed at Cordoba.

No. 539. γ SAGITTARII.—3½ Lacaille; 3-4 Heis and Behrmann; 2·8 Gould (1872, 1874) who says it "seems somewhat variable with

a long period." Sir J. Herschel made γ Sagittarii 0·23 m. fainter than π Scorpii, whereas Dr. Gould makes γ 0·6 m. the brighter of the two.

September 5, 1874, I found γ very nearly, but not quite equal to δ Sagittarii.

No. 540. LALANDE 33212 HERCULIS.—7 m. Lalande and Harding. I could not see any trace of this star with the binocular, April 27, 1878.

No. 541. O.A. 17670 SAGITTARII.—Rated 4½ m. by d'Agelet in 1783, and estimated 5, 7 and 5½ by Argelander. The Cordoba estimates vary from 5·8 to 7. It is not given by Lalande or Heis. It is 6 m. in *Harding's Atlas*, and marked with a line under it. 5·93 H.P.

No. 542. 72 OPHIUCHI = O Σ 342.—3-4 Heis; 3·6 Gould; 3·92 Pritchard (1882·483). A supposed close double star, the companion being suspected of variation. It was discovered as a double star on November 1, 1841, mags. 4, 7, but was seen single on May 14, 1842. If was again seen double 1842·72, but was again found single in 1844, 1845, 1848, 1850, 1851, 1852, and 1859. In 1876, however, M. Struve again saw the satellite very distinctly, position 156°·0, distance 1″·6, and considers that the star is really double, but that the companion is subject to great fluctuations of light. In 1859, Secchi found the star well separated, only 3 weeks before it was found single at Pulkowa! (*Nature*, April 10, 1879). Burnham found it "certainly single; first-class night" (1880·592) with 18½ inch refractor (*Memoirs*, *R. A. S.*, vol. xlvii., p. 296).

No. 543. BIRMINGHAM 427 SAGITTARII.—8 m. Lalande (33287); 8 m. d'Arrest; 8 and 7·5 Argelander; 8·3 Birmingham, 1875, May 26, and 8 m. July 25, but not seen 1876, April 13.

No. 544. LACAILLE 7646 SCORPII.—6½ Lacaille; 7-6 *Cape Catalogue* (1878·61). Suspected variable by Gould, but the evidence derived from the Cordoba observations is conflicting, owing to the apparent variation of several of the comparison stars (*U. A.*, p. 288).

No. 545. YARNALL 7736 SAGITTARII.—5½ m. Yarnall, 1868, June 26, and 7½ m., July 1. Rated 6·4 at Cordoba in April and May, 1877, but not observed in 1871–73. It is not in *Lalande's Catalogue*, but is 9 m. in *Harding's Atlas*.

No. 546. LACAILLE 7681 SAGITTARII (= LALANDE 33732).— 6½ Lacaille; 6 Lalande; 7, 6, and 6½ Argelander; 6·0 and 5·7 Yarnall (1868). Not given by Heis or Behrmann. The Cordoba estimates are 6·7 and 7·0; and Gould says "the star appears clearly to be variable, and I regret my inability hitherto to secure determinations of its limits of magnitude." I observed this star August 6, 1877, and estimated it exactly equal to Lacaille 7660 (6·9 m. Gould).

No. 547. Lacaille 7686 Sagittarii (= 6222 B.A.C.)—7 m. Lacaille; 7 m. Harding; 7½ m. Argelander, but rated 6·5 by Yarnall and 6-7 by Heis. It was found "little, if any, above 8 m." at Cordoba.

No. 548. η Serpentis.—4-3 Sufi; 3 m. Argelander and Heis; 3·5 Gould; 3½ Franks. Smyth says, "this star is suspected of being variable." 3·65 Pritchard (1882·472). On August 22, 1876, I found η slightly brighter than θ Serpentis, but less than λ Aquilæ; October 21, 1876, η Serpentis distinctly less than β Ophiucii (both 3 m. Heis), and about = ν Ophiucii (4-3 Heis). Sir J. Herschel's estimates make η Serpentis 0·49 m. brighter than ϵ Ophiucii, whereas η Serpentis was estimated 0·2 m. the *fainter* at Cordoba.

No. 549. ϕ Draconis.—4-3 Sufi; 5 and 4½ Lalande; 4-5 Argelander and Heis; 4·7 in D.M.; 4·22 Pritchard (1882·731). Suspected variable by Gemmill (*English Mechanic*, November 16, 1883). In October, 1875, and December 1876, I found it less than χ Draconis; 1884, March 4 and 18, ϕ three steps less than χ; April 2, ϕ four steps less than χ. 4·21 and 4·4 H.P.

No. 550. κ Coronæ Australis.—6 m. Lacaille (7758); 5-6 Heis; 5·4 Gould; 6-7 *Cape Catalogue* (1877·65). A fine double star 6, 7; 359°·3: 21″·78 (1836). I found the components white and reddish yellow, 3 inch achr. 1875 (in India), with a faint and distant *comes n. f.*

No. 551. 42 Draconis.—5 m. and 9 m. Lalande. (9 perhaps a misprint for 6?). Sir W. Herschel gives 27 (*f*). 42·36; 6 m. Groombridge; 5-6 Heis; 5 m. Franks, and = 36 Draconis, August 15, 1877. 4·98 H.P.

April 19, 1878, I found 42 about ½ mag., less than π Draconis, but slightly brighter than 36; November 3, 1878, 42 = 36; October 5, 1879, 42 slightly less than 36; March 4, 1884, 42 one step brighter than 36; April 2, 1884, 42 one step less than 36.

No. 552. Birmingham 447 Aquilæ (= Lalande 34307 (7 m.)—Birmingham considers this star to be probably variable in colour. It was noted by Schjellerup as "roth," but Birmingham found it "blue" (!), May 18, and July 20, 1873.

No. 553. Birmingham 448 Lyræ. — Birmingham says in his *Catalogue of Red Stars*: "From several observations, I conclude this star to be a variable of short period between 8 and 9 mag." It is 8·5 in the *Durchmusterung*, but has not been found in any other Catalogue.

No. 554. α Scuti = Lalande 34374-5.—4½, 4 Lalande; 5 Harding; 4-5 Heis; 5·2 Johnson (1857). The Cordoba estimates are 3·7, 3·6, and 3·5 in 1872 (*U. A.* p. 322). I found this star equal to 12 Aquilæ in August, 1875, and October, 1876.

No. 555. O Σ 358 Herculis.—A double star, 6·8, 7·2: 202°·1: 1″·8; components suspected variable. A probable binary.

No. 556. α LYRÆ (VEGA).—There is a suspicion of variability with reference to a distant comes to this bright star. Its position is about 42°, and distance 139″. In October, 1870, it was a magnitude fainter than Herschel's well known companion (Burnham 10·5 m : 154°·9 : 48″, 1878). Smyth alludes to a star in the *n. f.* quadrant, which may be the one in question. Variation has also been suspected in Herschel's companion. It was measured by Dembowski in 1865 with a 7½ inch refractor shortly after sunset, and rated by him 8·8 m. of Struve's scale (about = 9½ Smyth).

No. 557. LALANDE 34746 AQUILÆ.—7 m. Lalande. Not given by Bessel or Santini (*Nature*, April 20, 1876). It is an orange star, and No. 457 of *Birmingham's Catalogue of Red Stars.* Birmingham rated it 7·5.

No. 558. ϵ^1 and ϵ^2 LYRÆ.—The well known quadruple (or multiple) star. Struve suspected alternately variable light in the components of ϵ^2, and Grover found the *debilissima* of Herschel alternately variable (*Cel. Obj.* p. 343).

No. 559 - 29 SAGITTARII (= 6399 B.A.C.). Not in *Lalande's Catalogue;* not in *Argelander's Uranometria*, but 5 m. in one of his zones; 6–7 Heis; 6 m. Behrmann; 6 m. Franks, July 24, 1877. In the *Uranometria Argentina* it is incorrectly identified with Lalande 34915, which lies about 1° to the north of it. The Cordoba estimates were 5·9 in 1871, and 5·4 and 5·5 in 1873. Dr. Gould says "the indications of variability are strong."

No. 560. BIRMINGHAM 464 AQUILÆ.—Not in *Lalandé's Catalogue* or *Harding's Atlas.* Birmingham's estimates of magnitude, 1873–1876, vary from 7 to 8 m.; 9·5 Webb, 1873, September 22.

No. 561. LALANDE 35150 SERPENTIS.—6 m. Lalande; 6½ Bessel; 6 m. Argelander and Heis; 5·9 DM; 6·1 Gould (at Albany), and 6·6 at Cordoba. Dr. Gould suspects variation.

No. 562. σ SAGITTARII.—3 m. Ptolemy and Sufi; 2½ Lacaille; 2–3, Argelander, Heis, and Behrmann: 2·41 Sir J. Herschel (*Cape Obs.*, p. 440); 2·4 Gould; 2½ *Cape Catalogue*, 1880; 2·30 H.P.

Smyth says (*Bedford Catalogue*, p. 435), "This star has been placed among the variable ones, under a probability of its varying from the 2nd to the 4th magnitudes; but its low altitude might occasion apparent changes. Ptolemy, Ulugh Beigh, Bradley, De Zach, and Mayer have classed it 3; Flamsteed 3½; Tycho Brahé and Hevelius 4; but Bode makes it 2; and Lacaille and Pigott 2½."

In August, 1876, I found it (in the Punjab) about equal to ϵ Sagittarii (3–2 Heis), but less than λ Scorpii. Heis rates λ Scorpii at 3 m. It is now about 2 m. (2 m. Behrmann). Heis' estimate, however, of 2–3 for σ Sagittarii is about right.

No. 563. θ Serpentis.—4 m. Sufi; 4–3 Heis and Argelander; 3·9 Gould (at Albany); and 4·2 at Cordoba. Smyth says, "There is much uncertainty as to its magnitude. Ptolemy ranked it δ in brightness, and was followed by Ulugh Beigh, Lacaille, and Pigott; Tycho Brahé, Hevelius, Bayer, Flamsteed, Bradley, and De Zach made it of the 3rd magnitude; Piazzi and myself saw it constantly 4½; and Montanari found it of the 5th. It must therefore be variable, and should be carefully watched." In the *Phil. Trans.* for 1786, Pigott remarks, with reference to this star, "Montanari says he saw this star of the 5th magnitude, and that the next year it grew bigger. I examined it frequently in 1783, 1784, and 1785, and found it always less than δ Aquilæ, equal to β Aquilæ and P. Ophiucii; 4th magnitude." The Cordoba estimates vary from 4·1 to 4·6, and Dr. Gould thinks there are strong indications of variability in one of the components (*U. A.*, p. 322). (Franks 4½ and 5, July 29, 1877); 3·91 and 4·23 Pritchard (1882·472); 4·08 H.P.

Gould gives the magnitudes of the components as 4·5 and 4·7; but on one occasion at Harvard College a difference of 1·4 m. was noted (*Observatory*, April, 1883).

August 22, 1876, I found θ Serpentis slightly less than η Serpentis; October 21, 1876, θ Serpentis considerably less than δ Aquilæ, and but little superior to ϵ Aquilæ.

No. 564. 11 Aquilæ.—5 m. Lalande; 6½ Bessel; 5·3 D.M.; 5·0 Argelander and Heis; 5·3 Gould (at Albany); and 5·8 at Cordoba. Sir W. Herschel gives 11 , 10 and 18 $\bar{,}$ 11 , 10. Gould suspects variation, although he includes the star in his "Standards of Magnitude" (*U. A.*, p. 32).

In August, 1875, I estimated this star half a magnitude brighter than 10 Aquilæ; September 14, 1883, 11 at least one magnitude brighter than 10; November 17, 1883, 11 about one magnitude brighter than 10, and four steps less than 18 Aquilæ. These observations, compared with Sir W. Herschel's, would seem to point to 10 Aquilæ as the variable.

No. 565. ϵ Aquilæ.—3 m. Tycho Brahé; 4 Hevelius; 4 and 3½ Lalande; 4 Harding; 3·77 Sir J. Herschel; 4 Heis; 3·86 Pritchard (1882·583). Suspected of variation by Sir W. Herschel, who says (*Phil. Trans.*, 1796), "13 Aquarii (ϵ) September 3, 1784. It is not much larger than either 11, 18, or 19, so that we may be pretty certain it must have lost some of its lustre since the time of Flamsteed. In his observations it is marked 4 m." June 20, 1879, Franks found it nearly two magnitudes less than ζ Aquilæ, and equal to 111 Herculis; September 12, 1879, ϵ a little brighter than 110 and 111 Herculis; "certainly brighter than on June 20" (*private letter*). In August, 1875, I found ϵ about 4½ m., and very little, if anything, brighter than 111 Herculis. 4·10 and 4·3 H.P.

No. 566. 12 AQUILÆ.—4 m. Lalande (35482–4); 5 Harding; 5–4 Argelander; 4–5 Heis; 3·8 Gould. M. Goujon suspected variability in this star (*Comptes Rendus*, vol. xxvii., p. 111), and says, "Fl. (1690) called it 5 m.; Bradley (1750–1762) 5–6 m.; . . . Lalande 1794 to 1796, 4 m.; Piazzi 8 times 5–6." Gould says, "It may be a variable of long period" (*U. A.*, p. 95).

August, 1875, I found 12 distinctly brighter than 9, and about = 6 Aquilæ.

Franks rated it 4½ m., and "lucid yellow," July 27, 1877. Sir W. Herschel gives 1, 12 and 6·12, 9. Pritchard, 4·01 (1882·583).

No. 567. λ LYRÆ.—6 m. Lalande; 5·8 Argelander; 5–6 Heis; 4·5 Birmingham (November 1, 1876), who suspects variation.

April 6, 1884. I found λ 2 steps less than 17 Lyræ, but brighter than LL 35045.

No. 568. BIRMINGHAM 483 AQUILÆ.—7½ Lalande (35611); 7·5 Bessel; 7·5 Birmingham, September 16, 1876. Included by Schönfeld in his provisional list. He says, "Schmidt fand diesen sehr rothen Stern, October, 1872, langsam abnehmend. A.N. 80. 1912, vergl. auch 80. 1905."

No. 569. Y 8122 SAGITTARII.—With reference to this star, Gould says, "I have small doubt of the variability of this star, for which the estimates of magnitude vary from 6·3 to 7·0. Yarnall noted it in 1865 as 6·0, June 11, and 7·0 August 15. It does not occur in Argelander's zones."

No. 570. 18 AQUILÆ.—5 and 6 Lalande (35789–90); 5 Bessel; 5·2 in DM; 5 Argelander, Heis, and Gould; 5·6 at Cordoba. Gould suspects variation, although he includes it in his "Standards of Magnitudes" (*U. A.*, p. 32). Sir W. Herschel gives 18 ; 11. September 23, 1879, I found 18 = 31 Aquilæ; November 17, 1883, 18 about four steps brighter than 10 Aquilæ. 5·06 H.P.

No. 571. π SAGITTARII.—4 m. Ptolemy; 4–3 Sufi; 4 Ulugh Beigh, Tycho Brahé, Hevelius, and Lalande; 4½ m. Piazzi, Taylor and Maclear; 5–6 and 4 d'Agelet; 3 m. Argelander and Heis. The Cordoba estimates vary from 2·7 to 3·2, and Dr. Gould considers that the star has either increased since the time of the ancient observations, or is "subject to fluctuations of a very long period." 3·11 H.P.

No. 572. BIRMINGHAM 487 VULPECULÆ = LALANDE 35928 (6 and 7).—7 m. Bessel. Birmingham's estimates of magnitude vary from 6 to 7·5.

No. 573. P. XIX. 13 LYRÆ.—A quadruple star, 8, 11, 9·5, 12 : 337°, 350° : 18″·5, 74″·8 (9·5, 12 : 294° : 5″). Webb says, "12 var (?) should be watched; Hunt nearly equal, 1868; Sadler 0·5 less than 8·5, 1874."

No. 574. Lalande 36099 Aquilæ.—6½ m. Lalande; 7½ Bessel; 6·0 in DM; 6 Heis; and 6·4 to 6·7 at Cordoba. Suspected variable by Gould, although included in his "Standards of Magnitude" (*U. A.*, p. 323).

No. 575. 53 Draconis.—5 m. Groombridge; 5 Harding; 6–5 Heis; Sir W. Herschel gives the sequence 47–54, 53. 5 m. Franks, September 4, 1877 (*private letter*).

December 13, 1876. I found 53 slightly brighter than 54 (5–6 Heis).

May, 1877. 53 a little less than 54, and about = 51.

June 12, 1877. 53 about ½ magnitude less than 54.

April 9, 1883. 53 one step brighter than 54, but less than o (47).

March 7, 1884. 53 one step less than 54, and about 5·2 m.

No. 576. 43 (*d*) Sagittarii.—6 and 8 m. Lalande; 4 Harding; 5 Argelander and Heis; 5·6 Gould ("red"); 5 Franks, August 16, 1877 (*private letter*); 5 *Cape Catalogue* (1878·75). 4·90 H.P. My observations are:—

June, 1875. About 6 m.; much fainter than ρ^1, but brighter than ρ^2, and a 7 m. star *f*.

November, 1875. Rather brighter; about 5½ m.

October, 1876. A little less than υ (4·9 Gould).

No. 577. 24 Aquilæ.—6 m. Lalande (36326); 6–7 Heis; 6·8 Gould. Sir W. Herschel's estimates of magnitudes make it equal to 27 Aquilæ (6–5 Heis). Franks "components separately 7, 7, August 29, 1877" (*private letter*).

August, 1875. Both stars 6½ or 7 m.

September 23, 1879. 24 Aquilæ, 6·8 m.; one magnitude less than 23 or 27.

September 18, 1881. About 7 m.; at least one magnitude less than 23 or 27.

No. 578. Birmingham 492 Cygni.—7 m. Buckingham. Birmingham says, "The position closely agrees with Arg. + 26, 3529; 9 mag. If it is the same star it must be variable."

No. 579. 6624 B.A.C. Lyræ. Not in *Heis' Catalogue*; 7½ Franks. It seems to be Lalande (36503 (6½ m.); 7 m. Harding.

No. 580. χ^3 Sagittarii (49 Fl.).—6 m. Lalande; 6 Harding; 6–7 Heis. Not in Argelander's *Uranometria* or Zones; 6 Behrmann; suspected variable by Gould, from estimates at Cordoba, which vary from 5·6 to 6·2.

No. 581. 31 (*b*) Aquilæ.—5½, 7½ Lalande; 5 Harding; 6 Rumker; 5 Piazzi; 5–6 Heis; 5 m. in *Catalogue of Berlin Academy Charts*, 5·4 and 5·6 Gould. Sir W. Herschel found 31 the least perceptible diffe-

rence brighter than 28 Aquilæ. Piazzi says, with reference to 31, "Sequitur alia 7 mag. 4′ ad Boream," 5 Franks, August 29, 1877 (*private letter*). My observations are:—

August, 1875. 31 very slightly brighter than ω^1.
October, 1876. Slightly less than ω^1.
August 1, 1877. 31 slightly brighter than ω^1.
April 24, 1878. 31 equal to ω^1, but brighter than 28 and ω^2.
September 23, 1879. 31 slightly brighter than ω^1; about ½ a mag. brighter than 28; 31 about = 18. 31 is 5·30 and 5·5 H.P.

No. 582. LALANDE 36606 SAGITTARII.—Rated 8 m. by Lalande and Piazzi; 6·5 m. by Argelander, October 17, 1852. In the summer of 1851 it was seen about 9 m. (*Nature*, January 10, 1878). It is 8 m. in *Harding's Atlas*. It is not in the *Uranometria Argentina*.

No. 583. BIRMINGHAM 498 AQUILÆ (= Arg. 1° 4004).—8·5 Birmingham, 1876, August 10. "Variable (?)"

No. 584. LALANDE 36781 AQUILÆ.—Rated 7 m. by Hencke; 7 Bessel; 6·0 DM; 6 Argelander and Heis; and 6·6 at Cordoba. Gould suspects variation, although it is included among his Standard of Magnitudes" (*U. A.*, p. 33).

No. 585. α VULPECULÆ.—4½ and 5 Lalande; 4–5 Heis; 5 Franks (1877); 4·58 Pritchard (1882·604).

No. 586. LALANDE 36863 AQUILÆ.—7 m. Lalande. Gould's estimates vary from 6·3 to 7·2. It is 49 Heis Aquilæ (6–7). Not in *Argelander's Uranometria*. It seems to be identical with the double star P xix. 144 = Σ 2532; 7, 11 : 4°·9 : 37″ (1838), respecting which Smyth says (*Bedford Catalogue*, p. 449), "A and B point nearly upon a 9th magnitude star in the *nf* quadrant." Knott in 1862 failed to see this 9th magnitude.

July 4, 1877, I found LL 36863 less than LL 36890, which lies 32′ to the north of it.

No. 587. 36 (*e*) AQUILÆ (= Birmingham 500).—5, 5½ and 6 Lalande; 7 Lamont; 6 Bessel; 5·5 Schjellerup; 5–6 Heis; 5·6 Gould. Sir W. Herschel found 36, 42 and 36–45. Birmingham's estimates are:—7 m. April 18, 1873: 6 m. July 14, 1876. Webb 5 m. 1873, September 26; Burton 6·5, 1876, July 22; 7·5 July 24, 1876. My observations are:—August, 1875, 6 m.; October, 1876, and August 1, 1877, 6 m.; September 33, 1879, red with binocular, and 5·5 m.; September 18, 1881. 5·5 m.

No. 588. BIRMINGHAM 502 DRACONIS = LALANDE 37241 (7·5).—6·5 Argelander; 8 m. Fedorenki. Birmingham's observations, 6 to 6·5, 1872 to 1876; 9 m. Burton, 1876, July 19.

March 4, 1884, I estimated it 7 m. – more than a magnitude less than 59, but one step brighter than 56 Draconis.

No. 589. β CYGNI.—3–4 Sufi; 3 Ulugh Beigh, Tycho Brahé, and Hevelius; 3½ Lalande; 3·33 Sir J. Herschel (*Cape Obs.*, p. 440); 3 m. Heis; 3·02 Pritchard (1882·455). Klein states that from observations in 1862 and 1863 he found variation from 3·3 to 3·9 m. Webb also suspects variation. Espin thinks that β probably belongs to a distinct class of variables, like 63 Cygni, and that its period may be one of several years. Sir W. Herschel gives the sequences 53 (ϵ), 6 (β), 18 (δ) 18; 6 53 $\bar{,}$ 6 and 6 — , 14 Lyræ. 2·99 and 3·2 H.P.

No. 590. D. M. 17°, 3997.—Not given by Lalande or Harding. Rated 6, 6 and 6·5 by d'Agelet, 1783, July 26, 27, and 29; but only 9·4 m. in the *Durchmusterung* (*Nature*, December 22, 1881).

No. 591. μ AQUILÆ.—6 m. Sufi; 4½ Lalande; 5–4 Argelander and Heis; 4·4 Johnson; 4·8 DM; 4 m Franks, August 29, 1877. Sir W. Herschel gives the sequences 41 (ι) – 38 (μ). 44 (σ) 38, 32 (ν) 38 $\bar{;}$ 59 (ξ) and 67 (ρ); 38. 5·06 Pritchard (1882·586). Dr. Gould says it "has shown marked indications of variability both at Albany and Cordoba" (*U. A.*, p. 323).

No. 592. ι AQUILÆ.—This has been suspected of variation for some years. It was rated 4–5 by Sufi; 3½, 4 by Lalande; 4½, 6 by d'Agelet; 5 m. Harding and Piazzi; 4·2 Argelander; 4–5 Heis, and 4·6 by Gould. Sir W. Herschel found $\eta - \iota - \mu$ and $\iota - \nu$ and ι $\bar{,}$ 71; 4·52 Pritchard (1882·586). Dr. Gould says the Cordoba observations "give reason to suspect some fluctuations" (*U. A.*, p. 324). My observations are:—August 1875, 4½ m.—brighter than ν; October 1876, brighter than ν, but slightly less than 12 Aquilæ; August 4, 1877, same as last; September 23, 1879, ι considerably brighter than ν, nearly 1 magnitude; September 18, 1881, ι considerably brighter than ν. 3·89 H.P.

No. 593. STRUVE 2545 AQUILÆ = LALANDE 37207.—A double star, 6·2, 8·1 : 318°·5 : 3″·5. A third star 170°± : 20″, discovered by Mitchell in 1846, was rated 11 m. by Mitchell and Dawes, but only 15 m. by Knott.

No. 594. σ DRACONIS.—5–4 Sufi; 5–6 Argelander and Heis; 4 m. Groombridge. Sir W. Herschel gives $\pi - \sigma -$, 55 and ρ, σ. 5 m. Franks, September 11, 1877 (*private letter*). 4·74 H.P.

December 13, 1876, about equal to τ Draconis.

June 12, 1877, distinctly less than τ, and about = υ Draconis.

April 9, 1883. σ three steps less than τ, but two steps brighter than υ, or magnitude 4·9.

March 4, 1884. σ one step less than τ, or 4·7.

April 2, 1884. σ a mean between τ and υ, or 4·8.

No. 595. 6728 B.A.C. CYGNI.—7 m. Lalande (37313). Not in *Heis' Catalogue*; 6½ m. Franks, 1877.

No. 596. χ AQUILÆ.—5 and 5½ Lalande; 6 m. Bessel; 5·7 D.M.; 6 Argelander; 6–5 Heis; 5·7 Gould at Albany, and 5·8 at Cordoba. Sir W. Herschel gives 47 (χ) . 52 (π), and 47, 46. Dr. Gould suspects variation, although he includes it in his "Standards of Magnitude" (*U. A.*, p. 33). 5·40 and 5·8 H.P.

August, 1875, I found $\chi = \psi$, Aquilæ.

October, 1876, a little brighter than ψ.

November 17, 1883, χ three steps brighter than π, and four steps brighter than ψ.

No. 597. BIRMINGHAM 510 AQUILÆ = LALANDE 37504 (7½ m.).—9 m. Bessel; 8 m. Schjellerup; 8·5 Wolfers; 7 m. Birmingham, September 23, 1874; 9 m. Webb, September 25, 1873.

No. 598. D.M. 41°, 3469 CYGNI (= LALANDE 37619–20).—6 m. Lalande and Harding. Suspected variable by Peirce, who says (*Harvard College Annals*, vol. ix.), "Although I make this star 5·6, and the D.M. marks it 5·8, it is omitted by both Argelander and Heis, and its variability is highly probable. When I first observed it, it seemed brighter than 14 Cygni, but I think its light afterwards diminished."

November 25, 1878, I found it about half a magnitude less than 14, but slightly brighter than a star *n.f.* 14.

October 5, 1879, rather more than half a magnitude less than 14.

November 12, 1882, much less than 14, but two steps brighter than the star *n.f.* 14.

No. 599. LALANDE 37621 CYGNI.—6 m. and 7 m. Lalande; 6 Harding, suspected variable by Herr Köhl of Copenhagen, in March and April, 1878, when he found it a whole magnitude fainter than a star to the south of it. "Formerly he had observed them to be equal, and they are so given by Argelander." The southern star seems to be Lalande 37584–5 (5½ and 6), 6 m. Harding.

April 30, 1883, I found the star more than half a magnitude fainter than the star to the south. If it ever equalled this star in its present brightness, it must certainly be variable.

August 30, 1883, about the same magnitude.

October 14, 1883, one magnitude at least less than the star *s* of it.

October 19, 1883, at least one magnitude less than the star *s* of it.

No. 600. P. XIX. 276 CYGNI.—A double star, 8, 8·5 : 126°·5 : 15″. Dembowski considered the components variable.

No. 601. BIRMINGHAM 514 CYGNI.—Observed by Birmingham as 10 m. and red, August 19, 1870. This observation was confirmed by Webb, September 1, 1870, but the star was not seen subsequently.

No. 602. π AQUILÆ.—7 m. Bessel; 5·8 D. M.; 6, Argelander and Heis; 6·1 Gould (at Albany), and 6·6 at Cordoba. Suspected variable

by Gould, although it is included in his list of "Standards of Magnitude" (*U. A.*, p. 33). Sir W. Herschel gives 47 (χ) ·52(π) ·61(ϕ). In August, 1875, I found π slightly fainter than o Aquilæ.

No. 603. ϵ PAVONIS.—4 m. Lacaille; 4–3 Behrmann; 4·33 Sir J. Herschel (*Cape Obs.*, p. 344); 4 m. *Cape Catalogue* (1874·69). The estimates of magnitude at Cordoba vary from 3·6 to 4·2, and Dr. Gould says it "is of a remarkably blue colour."

No. 604. LALANDE 37868 VULPECULÆ.—5 m. Lalande; 5·7 D. M.; 5–6 Heis; not in Argelander's *Uranometria*. According to Schmidt (A. N. 2219), it is Bessel Weisse, 1501, 7 m.; early in September, 1878, he estimated it 6·75, and says its visibility is difficult owing to its being in the neighbourhood of another 5 m. star (13 Vulpeculæ). It is 6 m. in *Harding's Atlas*. On October 6, 1879, I found this star less than 12 Vulpeculæ (6–5 Heis), and about equal to 14 Vulpeculæ, or about 6 m.; slightly less than a star *s.f.*

No. 605. 9 SAGITTÆ.—6 m. Lalande (37856); 6–7 Heis; not in Argelander's *Uranometria*. Sir W. Herschel gives 8 (ζ) – 9.

No. 606. ϵ DRACONIS.—4–3 Sufi; 4 Argelander; 4–3 Heis; 4 m. Franks (> π), September 11, 1877 (*private letter*); 3·72 Pritchard (1882·371). A probable variable. From observations in 1882–83, Gemmill infers a probable period of 68 days ±, with a maximum about end of March, 1883. His estimates of magnitude vary from 3·8 to 4·8. It is a double star (5·5, 9·5 : 361°·4 : 2″·9), and the companion has also been suspected of variation.

December 13, 1876, I found it a little brighter than π (5 m. Heis).

April 9, 1883, ϵ one step less than χ, and more than half a magnitude brighter than π, or about 4·0 m.

March 4, 1883, $\epsilon = \chi$ Draconis, or 3·9; March 18, one step less than χ or 4·0; April 2, 1884, two steps less than χ or 4·1.

No. 607. β AQUILÆ.—3 m. Ptolemy; 3–4 Sufi; 3 Lalande; 4 Hevelius and Harding, Argelander and Heis. Sir W. Herschel gives δ, β. η; 3·92 Sir J. Herschel; 3·9 Gould; 3½ Franks, Aug. 29, 1877; 3·67 Pritchard (1882·589). Smyth says (*Bedford Catalogue*, p. 464):—"It is not now so bright as γ or δ, which could not have been the case in Bayer's time. Ptolemy marked it γ in brightness, as did also Ulugh Beigh, Tycho Brahé, Bradley and Lacaille; Flamsteed, Piazzi and Zach rate it 3½; but Hevelius could enter it no larger than the 4th magnitude." 3·95 H.P.

No. 608. 10 SAGITTÆ.—6 m. Lalande (38016); 6–5 Heis; 6 m. Franks, Aug. 30, 1877. Sir W. Herschel gives 11, 10·15.

Oct. 7, 1879. I found 10 about half a magnitude less than 11 Sagittæ (Heis 6 m), or 6·5 m.

Nov. 2, 1879. 10 two steps less than 11, or 6·2 m.; Nov. 2, 1882, 6·2.

No. 609. η CYGNI.—4–3 Ptolemy; 5 m. Sufi; 6 m. Flamsteed; 5 and 4 Lalande (38092–3); 6 Flamsteed; 6–7 m. Piazzi; 3 m. Bessel (Sept. 8, 1828); 4–5 Argelander and Heis; 4–5 Houzeau; 4½ Franks, Aug. 31, 1877 ("very bright for its magnitude"); 4–10 Pritchard (1882·430). These estimates of magnitudes would seem to imply variation of light. Sir J. Herschel drew attention to its probable variability in 1842 (see *Nature*, Aug. 12, 1880). Sir W. Herschel gives 21 (η) ·41 and 21 - - 17.

Nov. 9, 1876. I found η = 41 Cygni.
Aug. 1, 1877. η very slightly less than 41 Cygni.
April 19, 1878. Brighter than 17 and 28.

No. 610. 62 (c) SAGITTARII.—5½ Lacaille (8315); 5 Harding; 5 Heis. The Cordoba estimates vary from 4·6 to 5·3, but are doubtful according to Gould on account of the possible variability of the comparison stars ω and b Sagittarii (*U. A.* p. 291).

No. 611. LALANDE 38405–7 and 38409 AQUILÆ.—Rated 6 m. by Lalande, July 15, 1794; 7 m., Aug. 15, 1794; 8 m., Aug. 20, 1794; and 7½ m., Aug. 30, 1795; 6 m. Harding; 8 m. Bessel; 7 m. Berlin Academy Charts; 6–7 Heis and Houzeau. It is not in Argelander's *Uranometria*. It was estimated 7·1 at Cordoba (*U. Argentina*, p. 324 (LL 38409)). About 20′ *n* of and a little *p* is Lalande 38388–90.

Aug. 31, 1877. I found it less than LL 38388; also less than LL 38214–15, but brighter than an 8 m. star *np* (LL 38342–4).

No. 612. 27 (b') CYGNI.—6½ Lalande (38541); 6 Harding; 6–5 Heis; 6 m. Franks, Sept. 21, 1877. Sir W. Herschel gives 36–27.

No. 613. LALANDE 38506 AQUILÆ.—6 and 6½ Lalande; 7 Bessel; 6 m. Argelander and Heis, but estimated only 6·6 at Cordoba. Gould suspects variation, although the star is included in his list of "Standards of Magnitude" (*U. A.* p. 33).

No. 614. 66 AQUILÆ.—6 m. Lalande; 5 Harding; 6–7 Heis; Sir W. Herschel gives the sequences 42·66, 64, and 66·62. 6 m. Franks (rather > 64), Sept. 12, 1877; 5·8 Gould, who calls it red. In October, 1874, I found this star about 5½ m., and slighly brighter than 62, which is rated 6 m. by Heis (6·1 Gould).

Oct., 1876. About the same relative brightness.
Aug. 1, 1877. 66 = 62, but distinctly brighter than 64 (6·7 Gould).

No. 615. LACAILLE 8381 SAGITTARII (= LL 38711).—6 m. Lacaille and Lalande; 6 Heis; 6–5 Behrmann; variously rated from 4½ to 6 by Argelander; 6 m. *Cape Catalogue* (1878·61). The Cordoba estimates vary from 6 to 6·3.

No. 616. LACAILLE 8385 SAGITTARII.—7 m. Lacaille. According to Dr. Gould, the Cordoba observations of this star are very discordant, "varying through six-tenths of a unit, and strongly suggesting variability in its light."

No. 617. STAR NEAR CARRINGTON 3082.—Rated 9–10 by Argelander, but estimated only 11·2 m. by me, March 15, 1880. It lies closely north of Carrington 3082 (8·3 m.). This latter star is the nearest conspicuous star south of the variable R Cephei. The place given in the catalogue is only approximate, but the small star in question will be readily found from the above description.

No. 618. CARRINGTON 3106 URSÆ MINORIS.—8·8 m. Carrington. It lies *s.f.* Carrington 3082 (referred to in the last note). It is 9·4 m. in *Johnson's Catalogue* (No. 140), (*Radcliffe Obs.* vol. xv.), where Carrington 3082 is rated 8·4; but he says that in Feb., 1856, it was "certainly a magnitude brighter than No. 137 (Carrington 3082), and not under 7·5."

Sept. 13, 1879. I found this star about 0·4 m. less than Carrington 3082, or about 8·7 (3-inch refractor).

March 15, 1880. I estimated it 8·8 m.

March 30, 1881. Estimated 8·7 m.

No. 619. V. CAPRICORNI.—7½ m. Lalande (38839); 7 m. Harding; 7 m. Argelander; 6½ m. Sir J. Herschel, who says:—"A fine ruby star. This is the finest of my ruby stars." 6 m. Webb, Sept. 3, 1873; 7·5 Birmingham. In July, 1875, with 3-inch refractor, I found the star only 8½ or 9 m., and fiery red; Nov., 1876, 8½m, and much fainter than a 7 m. star *n.f.* 4 Capricorni, colour fiery red, 3-inch refractor, visible with binocular; 2nd Aug., 1877, about the same magnitude. Secchi also suspected variation; and he estimated the star at 7·5, July 15, 1868, deep red; 7 m. Sept., 1869.

No. 620. - 7001 B.A.C. CYGNI.—6 m. B.A.C. Not in *Heis' Catalogue*. 7 m. Franks, 1877.

No. 621. α PAVONIS.—1½ m. Lacaille; 2 m. Behrmann; 2·33, Sir J. Herschel, who says "Variable (?)" his estimates of magnitude vary from 1·99 to 2·55. It is 2 m. in the *Cape Catalogue* (1875·65), and 2·1 in the *Uranometria Argentina.*

No. 622. LALANDE 39222 AQUILÆ.—5 and 6½ Lalande; 7½ Piazzi; 6 m. Argelander and Heis; 6·5 in D.M.; 6·0 Gould (at Albany). The Cordoba estimates vary from 5·8 to 6·4.

No. 623. BIRMINGHAM 558 DELPHINI. —7, 6 and 6½ Lalande, Birmingham's estimates of magnitude (1872-1876) vary from 6 m. to invisibility. He says "the star is certainly variable." The Cordoba estimates are 6·4, 6·6, and 6·7. Lynn states that he observed this on

October 16, and October 29, 1872, and on the latter date it was nearly 2 magnitudes fainter than on the 16th. Schönfeld includes the star in his provisionial list, and says, "Die Verändelichkeit ist wesentlich aus den Grössenschatzungen der Cataloge geschlossen, vielleicht auch in Birmingham's eigenen Beobachtungen ausgesprochen. Seit April 21, 1874, hat sich der Stern höchstens um ein paar Stufen verändert."

October 7, 1879, I found this star about 6·3 m. slightly less than 1 Delphini; November 10, 1879, same brightness 6·3.

No. 624. π CAPRICORNI.—5½ and 6 m. Lalande; 5 Heis; 4-5 Houzeau (1875·36); 5·5 Gould. Sir W. Herschel gives ρ, π, o and π, σ and π, 15 (v). 5·22 H·P·

October 18, 1876, I found π very slightly less than ρ Capricorni (5-6 Heis).

August 2, 1877, $\pi = o$ (5-6 Heis), and about ¼ mag. less than ρ. Franks π = 5½ m. ($< \rho$), September 12, 1877 (*private letter*).

No. 625. - CAPRICORNI.—Not in *Lalande's Catalogue*, or *Harding's Atlas*. Variously estimated at Cordoba from 6·8 to 8½.

No. 626. ρ PAVONIS.—3½, and 6 Lacaille; 5½ Ellery; 5 Behrmann; 4·9 Gould, who suspects variation from 4·7 to 5·3; 5 m. in the *Cape Catalogue* (1875·68).

No. 627. θ CEPHEI.—4 m. Ptolemy and Sufi; 5 m. Harding; 4 Heis; 5 Franks, October 3, 1877. Sir W. Herschel 3 (η) -, 2 (θ). 4·24 Pritchard (1883·011). 4·33 H.P.

No. 628. ω^3 CYGNI.—5 Harding; 6-5 Heis; 5·53 Peirce. Called ω^2 by Heis (=7091 B.A.C.) 6 m. Franks and $=\omega^1$. Schmidt calls it "deep golden yellow;" Smyth, "pale red," and Sadler, "yellowish red."

December, 1876, I found ω^3 reddish, and slightly brighter than ω^1; May 21, 1883, ω^3 three steps brighter than ω^1.

No. 629. η DELPHINI.—6 m. Sufi, Lalande and Harding; 6-5 Argelander and Heis; 5·9 and 5·8 Gould (*U. A.*, p. 34). It is considered to be slightly variable by Franks, being sometimes equal to ι Delphini, and sometimes decidedly inferior (*English Mechanic*, August 30, 1878). Sir W. Herschel gives 5 (ι) . 3 (η), 8 (θ). 5·18 and 5·4 H.P.

No. 630.- 47 CYGNI.—6 m. Sufi; 5 and 4½ Lalande (39721-2); 5-6 Heis; 5 Franks (=39), September 21, 1877 (*private letter*); Sir W. Herschel gives 47 - 39. Webb calls it orange; Birmingham, 1876, "beautiful light orange," 5 m. My observations are:

November, 1865, I found 47 very slightly less than λ (5-4 Heis).
August 1, 1877, a little less than λ.
November 24, 1878, a little less than λ, or about 5 m.
October 6, 1879, about 5 m.
November 6, 1882, 47 = λ, or about 4·7, and reddish, with binocular.

No. 631. P. xx. 257 Draconis.—This seems to be No. 212 of Draco in *Heis' Catalogue*, where it is rated 6 m., and identified with 7124 B.A.C. Not in *Argelander's Uranometria*. 6 m. in *Harding's Atlas*; rated 6½ m. by Franks, 1877, and = P. xx. 265, and suspected of variation. March 4, 1884, I estimated it 6·2—four steps less than ψ^2 Draconis, and much less than 73. 6·50 and 6·2 H.P.

No. 632. υ Pavonis.—4 m. and 5 m. Lacaille; 5 m. *Cape Catalogue* (1874·64). The Cordoba estimates of magnitude during 8 years vary from 5·2 to 6·1, and Gould considers its variability highly probable (*U. Argentina*, p. 246).

No. 633. ι Delphini.—6 Sufi; 5 Lalande (39814-15); Sir W. Herschel gives 7 (κ), 5 (ι). 3 (η). 5·3 in *Durchmusterung*; 6 m. Argelander; 6-5 Heis; 5·8 and 5;9 Gould; 5½ Franks, September 2, 1877 (κ = 5 m. and η = 6 m.). My observations are:—

August, 1875, about 1 magnitude fainter than κ (5 m. Heis).

August, 1876, a little less than κ.

August, 1877, slightly less than η.

October 7, 1879, slightly brighter than η, and slightly less than κ, or about 5·3 m.

No. 634. 71 Aquilæ.—4½ m. Lalande (39803); 5½ Bessel; 4·7 in D. M.; 5–4 Heis; 4·2 Gould (at Albany). The Cordoba estimates are 4·4 to 4·6, and Gould says, "There is some grounds for suspecting it to vary a little" (*U. A.*, p. 324). Sir W. Herschel gives 71–70 and 41 (ι) ; 71. In August, 1875, I estimated it 4½ m., and brighter than 70 Aquilæ. 4·63 Pritchard (1882·589).

No. 635. Red Star near α Cygni.—Found by Birmingham, May 22, 1881, 2°51′·7 north of α Cygni, of a deep red or crimson colour, 9 mag., and suspected by him to be variable. He observed it on June 2 and 6 to have increased from 9 m. to 8·4, but on July 20, it had again sunk to 9 m. It "forms with three other stars, the southern end of a little inverted and irregular cross" (*Nature*, July 28, 1881). The star was observed a few days after its discovery, by Dr. Doberck, at Markree Observatory, Ward, Gledhill, Dr. Ball, Prof Krueger, and Dr. Kreutz. The latter stated that he had found an unpublished observation of the star on June 19, 1857, but not at any other time (*Nature*, June 23, 1881). Its spectrum was found by Eugen de Gothard, in 1882, "tolerably brilliant, with broad bands in the red, yellow, and blue. Colour intense red" (*Mon. Not. R. A. S.*, June, 1883). According to Ward (*Knowledge*, January 4, 1884), it probably varies from 8½ to below 12 m., with a period of over 12 months.

No. 636. Birmingham 569 Delphini (= Argelander 17°, 4401).—6·8 Argelander; 8 m. d'Arrest, September 10, 1874. It is not in *Lalande's Catalogue*; 8 m. Harding; 6–7 Heis.

No. 637. 118 Heis Cygni (= 7198 B.A.C. = Lalande 40156).—7 m. Lalande and Harding; 6 m. Heis; 6½ Franks, 1877. Peirce says (*Harvard College Annals*, vol. ix., p. 141), "118 Heis, and 123 Heis Cygni. The *Uranometria* only contains the former star as 5·8; Heis calls the former 5·8, and the latter 6·3; the D.M. calls the former 6·4, and the latter 5·4; and I call the former 7·0, and the latter 5·7. I only succeeded in observing Argelander's star once, and never failed to observe the other, which seemed to me brighter than 51 Cycni."

October 5, 1879, I found 118 Heis Cygni about 7 m.—less than Lalande 40221.

November 12, 1882, relative magnitude same as last observation.

May 21, 1883, 118 Heis faint, about 7 m. or 7·1; 123 Heis, two steps less than 51 Cygni (strong moonlight).

August 17, 1883, 118 Heis considerably less than the northern of two stars to the south of it; 123 Heis, three steps less than 51 Cygni.

No. 638. 13 Delphini.—6 and 6½ Lalande (40150–1); 6–5 Heis; 5·8 Gould; 5½ Franks, September 21, 1877 (*private letter*). It is included by Schönfeld in his provisional list. He says (quoting Schmidt), ",Im maximum 6 m., kurze Periode,' A. N. 74, 1770." Sir W. Herschel gives 13–14. 5·53 H.P.

No. 639. – 7219 B.A.C. Cygni.—*n.f.* a Cygni; 6 m. B.A.C. Not in Heis; 7 m. Franks, 1877. It seems to be Lalande 40251–2 (6 m. and 7 m.); 7 m. Harding. May 21, 1883, I estimated it 7 m., less than Lalande 40221; August 17, 1883, rather below 7 m.

No. 640. – 14 Delphini.—6½ m. Lalande (40227); 7 Bessel; 6 Heis; 6·4 Gould; 5·5 D.M. Included by Schönfeld in his provisional list. He says (quoting Schmidt) ",*U. N.* 6 m., 1869, August, 5, bis 6 Stufen schwächer und mit freiem Auge nicht sicher zu sehen,' *A. N.* 74, 1770." Gould suspects variation, although he includes it in his list of "Standards of Magnitudes" (*U. A.*, p. 34). Sir W. Herschel, 13–14.

No. 641. 123 Heis Cygni.—Not in *Lalande's Catalogue;* 6 m. *Harding's Atlas* (Map. 26, but not in Map 25), 6–7 Heis; not in Argelander's *Uranometria*. See note to 118 Heis Cygni (No. 637). My observations are—

October 5, 1879, 123 Heis Cygni nearly 1 magnitude *less* than 51 Cygni; brighter than Lalande 40221.

November 12, 1882, at least half a magnitude less than 51 Cygni; brighter than LL 40221.

May 21, 1883, about two steps less than 51 Cygni, and three steps less than 59 Cygni; brighter than LL 40221.

August 17, 1884, three steps less than 51 Cygni, or about 6·1 m.

No. 642. 55 Cygni.—6 m. Lalande (40310); 6 m. Harding; 5·06 Peirce (*Harvard College Annals*, vol. ix.); 6–5 Heis; 5 m. Franks, October 3, 1877 (*private letter*). Sir W. Herschel gives 56·55–59, and 55·63, and 63·55 , 59. 5·00 and 5·6 "est" H.P.

May 10, 1883, I found 55 one step less than 57 (5–6 Heis), and two steps brighter than 56 (6–5 Heis), or about 5·4 m.

August 17, 1883, 55 a mean between 56 and 57, or about 5·5.

September 4, 1883, 55 one step less than 56, or about 5·8

No. 643. 4 Aquarii.—Not in *Lalande's Catalogue*; 6–7 Heis; 6·2 Gould. A suspected variable by Peirce (*Harvard Annals*, vol. ix.). Sir W. Herschel gives 5 , 4.

I found it fainter than 5 Aquarii, October, 1875.

September 21, 1879, 4 about half a magnitude less than 5 Aquarii.

October 15, 1882, 4 three steps less than 5.

No. 644. 5 Aquarii. Not in *Lalande's Catalogue;* 5–6 Heis. Sir W. Herschel rated 5 very slightly fainter than 3 Aquarii. 6 m. Piazzi; 7 m. Bessel. At Cordoba it was estimated 5·1 in 1871, and 5·8 in 1872–1874 (*Uranometria Argentina*, p. 309). 5·52 H.P.

In October, 1875, I found it brighter than 4.

September 21, 1879, 5 about half a magnitude brighter than 4.

October 15, 1882, 5 about three steps brighter than 4.

No. 645. 32 Vulpeculæ.—5½ m. Lalande (40456); 5 Harding; 5–6 Heis. Suspected by Gilliss to be variable, and afterwards by Franks ("decidedly inferior to 31 Vulpeculæ," September 21, 1877). My observations are:—

December 1, 1874, fainter than 52 Cygni (4–5 Heis), and slightly less than 31 Vulpeculæ (5 m. Heis).

April 6, 1875, same relative brightness.

October 4, 1875, about half a mag. less than 31.

October 19, 1876, rather more than half a mag. less than 31.

August 4, 1877, about half a mag. less than 31.

No. 646. 7 Aquarii.—Rated 3 m. by Ptolemy; 6 Sufi, Lalande, and Harding; 7 m. Bessel; 5 m. Argelander; 6–5 Heis; and 5·9 by Gould and Espin. Gould suspects variation. Sir W. Herschel found $\mu - 7 - - 8$ and 18, 7. 5·69 H.P.

(See *Southern Stellar Objects*, p. 113).

October 15, 1882, I found 7 less than μ Aquarii, and very reddish, with binocular.

No. 647. Birmingham 573 Delphini.—8 m. Lamont and Bessel. Birmingham's observations (1872–1875) vary from 7·5 to 0; 8 m. Webb, 1873, September 12, 13, and 25. A 7·2 m. star (a wide double) closely *n.f.* is also suspected of variation (*Cel. Obj.*, p. 298).

November 25, 1878, I estimated it 7½ m.

No. 648. 37 HEIS CAPRICORNI.—6 m. Harding. Not in *Lalande's Catalogue*. 6–7 Heis, who says, "Stella ab Hardingio observata a me 17. Aug. 1852, et 19. Aug. 1865, nudis oculis videbatur, sed 17 Aug. 1863, et Sept. 23, et Sept. 27, 1870, non conspicua erat. Stella fortasse variabilis est." It is 6·6 m. in the *Uranometria Argentina*. The star lies *s.f.* θ Capricorni.

August 10, 1876, I found it about 6 m., and = 20 Capricorni; a little brighter than 21.

October 18, 1876, about the same magnitude.

November 1876, very slightly brighter than 21 – not equal 19 or 20.

August 30, 1877, brighter than 21, but less than 20 Capricorni.

No. 649. 27 CAPRICORNI = LALANDE 40948.—6 m. Lalande; 6 Heis; 6·6 Johnson (1858). The Cordoba estimates vary from 6·3 to 6·8. Sir W. Herschel gives 26 (χ^2) ·27. 6·16 H.P.

No. 650. 6 EQUULEI.—5½ and 7 m. Lalande (41055–6); 5 m. Harding. Not in the *Catalogues* of Ulugh Beigh, Tycho Brahé, or Hevelius; not given by Heis; 6·2 Gould; 5·89 H.P.

It lies closely *s.f.* γ (5) Equulei. Webb remarks that γ and 6 are "a striking pair." Sir W. Herschel says (*Phil. Trans.*, 1796), "In the *Catalogue* we have 4 m.; in the *Observations* Flamsteed has once marked it 6 m., and once 8 m. If there be any accuracy in these various notations the star must certainly be changeable."

I found it less than γ in September, 1877.

No. 651. P XXI., 21 EQUULEI.—6, 6½ Lalande (41136–7); 8 m. and 9–10 m. d'Agelet; 8 Piazzi; 9 Bessel; 7·5 in *Durchmusterung*; 7·0 Gould.

September 11, 1877, I found this star less than Lalande 41018 but brighter than Lalande 40977, and LL 41352.

No. 652. LACAILLE 8721 PAVONIS.—5½ and 6 Lacaille; 6 Behrmann; 5–6 *Cape Catalogue* (1874·71). Gould believes it to vary by not less than half a magnitude.

No. 653. 29 CAPRICORNI.—6 m Lalande; 5 Harding; 6 Heis. Sir W. Herschel found ι – 29 – 30; 5·7 Gould; 6 m. Franks, and = 30, Capricorni, October 4, 1877; 5·47 H.P.

September 30, 1876, I found it much less than ι, and about ½ mag. *less* than 30 (6 m. Heis).

October 6, 1879, 29 nearly half a magnitude *less* than 30.

Closely *n.p.* 29 is an 8½ m. star, Lalande 41220.

No. 654. BIRMINGHAM 579 CEPHEI.—7 m. Piazzi; 8 Argelander; 8·5 Secchi. Birmingham's estimates of magnitude (1872 to 1875) vary from 6·5 to 7·5; 9 m. Copeland, 1875, September 28; 8 m. Burton, 1875, August 10; and 7·6, 1876, August 12, 20, and 31.

No. 655. Lacaille 8768 Indi.—7 m. Lacaille; 6–7 *Cape Catalogue* (1876·75). The Cordoba estimates (1871–74) range from 6·1 to 7·3, and Gould considers establish the variability of this star.

No. 656. P xxi., 87 Capricorni (= 7413 B.A.C = LL 41494).—6 m. Lalande, Lacaille (8794), Argelander, Heis, and Behrmann; 6–7 Houzeau; 6·0 Gould; 7 Franks, "orange," October 4, 1877; 6 m. *Cape Catalogue* (1878·68). It is not in *Birmingham's Catalogue.* Harding shows a 6 m. star, with a 7 m. closely *s.f.* The 6 m. star seems to be Lalande 41494, and identical with 7413 BAC. 5·82 H.P.

No. 657. γ Pavonis.—3½ Lacaille (8778); 3 m. Gilliss (1851); 4·0 Ellery (1868); 4·5 at Cordoba; 4–3 *Cape Catalogue* (1873·62); 4·09 Sir J. Herschel, who says, "Very doubtful or variable"; his estimates make γ 0·47 m. brighter than ζ Pavonis, whereas Dr. Gould makes it 0·3 m. *fainter*.

No. 658. 1 Pegasi.—A double star 4, 9 : 310°·8 : 36″·4. Smyth says, "4 considered variable" (*Bedford Catalogue*, p. 499). It is 6, 4 and 4½ Lalande (41545–8), and is 4 m. in *Harding's Atlas;* 4·5 Heis; 4 Franks, October 5, 1877 (*private letter*). It was measured 3·4 by Johnson with the heliometer, 1851. Sir W. Herschal found 24 (ι) – 1 , 10 (κ) and 1· 9). Pritchard 4·30 (1882·645). 4·28 and 4·4 H.P.

No. 659. 33 Capricorni.—6 m. Lalande (41543); 5–6 Argelander; 6–5 Heis and Behrmann; 5·7 Gould (red). Sir W. Herschel gives 36, 33, 35 and 41, 33 and 28, 33, 35. Chacornac found it "sometimes brighter and sometimes fainter than a star of 7 magnitude near it." It is No. 581 of *Birmingham's Catalogue of Red Stars.* 6 m. Franks, October 3, 1877 (35 = 6½ m.), (*private letter*). 5·59 H.P.

In August, 1875, I estimated it 6½ m.

In August, 1876, it seemed about 6 m., and slightly brighter than 35 Capricorni, but much less than 36. About the same magnitude in October, 1876.

No. 660. 18 Aquarii.—6 m. Lalande, Harding, and Heis; 5·7 Gould. Suspected variable by Pierce at Harvard.

Sir W. Herschel gives 6 (μ) , 18 , 7. 5·38 H.P.

No. 661. γ Indi.—4½ and 5 Lacaille; 6 Behrmann; 5-6 *Cape Catalogue* (1875·70). The Cordoba estimates vary from 6·0 to 6·6, and Gould says "it seems clearly variable" (*Uranometria Argentina*, p. 247).

No. 662. Birmingham 584 Cygni.—11 mag. ruddy star in cluster, Schjellerup; 9 m. Secchi, who says "must be variable," (Notes to *Birmingham's Catalogue*, p. 323).

No. 663. β Cephei.—4–3 and 3–4 Sufi; 3 m. Harding and Heis; 3·45 Sir J. Herschel (γ Cephei = 3·48); 3½ Franks, October 14, 1877. Sir W. Herschel gives 35 (γ)–, 8 (β)–, 32 (ι). Schmidt considers this

star to be variable with a period of about 383 days (*Ast. Nach.*, 1069). It is a double star, 3, 8 : 251° : 13″·7, Webb, who says (*Cel. Objects*, p. 270), "Cornish 3 decreasing, 1879;" 3·53 Pritchard (1883·011).

November 22, 1875. I found it slightly brighter than γ Cephei.
December 14, 1876. β Cephei about ½ mag. less than δ Draconis.

No. 664. 7489 B. A. C. CYGNI.—6½ Lalande (42004); 6 m. Heis. Not in *Argelander's Uranometria;* 7 m. Franks, 1877, "quite invisible to naked eye" (*private letter*).

No. 664A. BIRMINGHAM 587 CYGNI = LL 42153.—7½ m. Lalande; 8 Harding; 6·7 Argelander; 7 Webb; 6·8 Birmingham, September 3, 1876. This star may possibly be identical with one measured 5·36 by Peirce (*Harvard Annals*, vol. ix., p. 137), "Following ρ Cygni," but which he could not afterwards find. He says (p. 141), "August 2, 1875, I could find no star which could possibly be identified with the one observed. The star was red." On November 25, 1878, I found Birmingham's star less than LL 42205 and LL 42376, but brighter than LL 42042. October 4, 1879, slightly brighter than LL 42205 and 42376.

No. 665. 41 CAPRICORNI.—6 m. Lacaille (8893); 6 m. Lalande (42235); 5 Harding; 6–5 Heis and Behrmann; 5·8 Gould. Sir W. Herschel gives 41, 33. 6 m. Franks, and = 33 Capricorni (1877); 6–7 *Cape Catalogue* (1878·74).

October 8, 1876. I found 41 = 30 Capricorni.
Closely *n.p.* is the cluster 30 Messier.

No. 666. ϵ PEGASI.—3 m. Ptolemy, Sufi and Lalande; 2–3 Argelander and Heis; 2·62 Sir J. Herschel (α and β Pegasi = 2·65) 2·3 Gould; 3 m. Franks, October 5, 1877. Schwab suspected variation in this star, and found a period of about 25⅔ days (A. N. 2220). Gould also finds fluctuations of brightness in his observations at Albany and Cordoba; at the latter place it was sometimes estimated as brighter than α Pegasi, and sometimes decidedly fainter, but never below 2·6m. Sir W. Herschel gives the following sequences :—8 (ϵ)–54 (α) 37 Cygni –8 21 And , 8 , 54 (α) 8 , 53 (β) 8; 16 Ceti and 8 , 24 Piscis Australis. Pritchard 2·43 (1882). 2·41 and 2·8 H.P.

September 4, 1883, and September 10, 1883, I found ϵ Pegasi about 0·3m. less than α Pegasi.

No. 667. 46 (c^1) CAPRICORNI.—6 m. Lalande (42369); 6 Harding; Sir W. Herschel found 46—, 47; 5 m. Heis; 5½ Gould; 5 m. Franks = ξ Aquarii (1877). Closely *n.p.* is Lalande 42368 (7½) (7·0 Gould).

August, 1876. I found 46 one magnitude brighter than 47 Capricorni. 46 = 5·21 H.P.

No. 668. κ PEGASI. A double star 4, 13 : 302°·5 : 12″·1. Webb found 13 more like 11 in 1852, and 13 in 1871. Dembowski considered it variable.

No. 669. Birmingham 596 Aquarii = Lalande 42431 (6½).—7·5 Bessel; 5–6 Secchi; July 15, 1868. Birmingham's estimates of magnitude, 1873–1876, vary from 6 to 8; 6·5 Webb, September 3, 1873. It is 6·8 in the *Uranometria Argentina*. From observations, 1880–1883, Espin finds that the star is certainly variable, but that the variation does not exceed a magnitude, with a period of, perhaps, several years (*Eng. Mechanic*, May 18, 1883).

September 6, 1877. I found this star 7½ m.—less than Lalande 42616.

Sept. 21, 1879. About 7½ or 8 m.; very slightly brighter than a star closely *s.f.* (LL 42445).

Sept. 10, 1883. About 7 m.; considerably brighter than the star *s.f.*

No. 670. - 28 Aquarii.—7 m. Lalande (42913); 6 m. Harding; 6 m. Heis. Sir W. Herschel found 28 , 30 (30 was rated 5–6 by Heis); 5·9 Gould; 6 m. Franks, Oct. 5, 1877.

Sept. 10, 1883. 28 three steps less than 32 Aquarii.

No. 671. Lalande 42958 Pegasi.—7 and 6 m. Lalande; 7 Bessel; 6·5 DM; 6–7 Heis; 6·1 Gould (at Albany), and 6·6 at Cordoba. Dr. Gould suspects variation, although he includes it in his list of "Standards of Magnitudes" (*U. A.* p. 35).

No. 672. Aquarii.—Suspected variable by Peters (A N 2434).

No. 673. 30 Aquarii.—4½ Lalande (42978); 5 Harding; 5–6 Heis; 5·8 Gould. Sir W. Herschel found the following sequences:—ρ , 30 30–60 28 , 30 and 30 - - 36. 5 m. Franks, Oct. 5, 1877 (κ = 5 m., Oct. 14, 1877). In Oct., 1874, I estimated this star as 6 m.—about = 51 , and decidedly fainter than κ (5-6 Heis). 5·57 H.P.

No. 674. Birmingham 600 Pegasi.—7·7 m. Argelander; 8 m. d'Arrest, July, 1874. Birmingham's observations:—8 m. Sept. 20, 1873; 6·5, Nov. 25 and 29, 1874; 7 or rather less, Dec. 2, 1874; 7·5–8, July 17, 1876. It seems to be Lalande 43043 (7½ m.).

No. 675. 32 Aquarii.—6 m. Lalande, Harding, and Heis; 5·7 Gould; 5 m. Franks, Oct. 5. 1877. 5·24 H.P.

In Sept., 1874, I found it less than *o* Aquarii.

Sept. 10, 1883. 32 three steps brighter than 28 Aquarii.

No. 676. υ Piscis Australis (= Lacaille 9030).—6½ Lacaille; 7 Brisbane; 5 Behrmann; 6-5 *Cape Catalogue* (1878·26); 5·4 Gould, who considers that "it has, perhaps, grown brighter in recent years (*U. N.*, p. 296).

No. 677. 2 Heis Lacertæ.—6 m. Lalande (43152); 7 m. Harding; 6-5 Heis; 4·6 in *Durchmusterung;* 5·35 Pierce; 5½ Franks, Oct. 17, 1877. Pierce says (*Harvard College Annals*, vol. ix. p. 141):—"I

have some slight suspicion of this star, founded on the discrepancies in my measures, and the fact that the DM makes it 0·8 brighter than Heis. The star is reddish." 5·34 and 5·0 H.P.

No. 678. LACAILLE 9036 PISCIS AUSTRALIS.—7 m. Lacaille; 5-6 Behrmann; 6 m. *Cape Catalogue* (1878·76); 5·7 Gould, who has "small doubt of its variability" (*U. N.*, p. 296). It is reddish.

No. 679. 36. AQUARII.—Rated 7 m. by Lalande (43183); 7 Piazzi; and estimated 7·2 at Cordoba; but seen by Heis with the naked eye, and rated 6·7. Not in *Argelander's Uranometria.* Sir W. Herschel gives 30 – – 36 and 37, 36.

No. 680. θ PEGASI.—3-4 Sufi, Argelander, and Heis; 3·60 Sir J. Herschel; 4 m. Franks, Oct. 14, 1877 (*private letter*). Sir W. Herschel gives 42 (ζ), 26 (θ) 46 (ξ). The Cordoba estimates vary from 3·2 to 3·8; and Dr. Gould believes that it "varies about half a unit" (*Uranometria Argentina*, p. 338); 3·53 Pritchard (1882·658). 3·76 H.P.

Sept. 10, 1883. I found it one step brighter than ζ Aquarii or 3·4 m.

No. 681. LALANDE 43239-40 AQUARII = 7726 B.A.C.—5 and 7 m. Lalande; 5 Harding; not in *Heis' Catalogue;* 6·3 Gould; 6 m. Franks, Oct. 14, 1877.

Aug., 1876. Equal to LL 43226 (6·5 Gould).

Sept. 6, 1877. Less than Lalande 43315 (rated 6·7 by Gould).

No. 682. 39 AQUARII.—6½, 6 Lalande (43289-91); 6 Harding; 7 Piazzi and Bessel; 6·7 Heis. Not in *Argelander's Uranometria*, but 6½ in his Zones. Sir W. Herschel gives 42·39, 45. The Cordoba estimates vary from 6·1 to 6·6; and Dr. Gould thinks it probably variable (*U. N.*, p. 310).

No. 683. BIRMINGHAM 607 LACERTÆ (= Lalande 43408-9 (5 m.)).—4·5 Argelander. It seems to be 5 Heis Lacertæ, identified with 7765 B.A.C, and rated 5 m. Birmingham's observations:—1873, 1874, 4·5 m.; 5·4 Copeland, Sept. 11, 1875; 7·5 Burton, 1876, and 5 m. Aug. 20; 5·5 Oct. 10. 4·65 and 4·9 H.P.

Oct. 8, 1879. I found it rather more than half a magnitude less than 1 Lacertæ (4·67 Pritchard), or about magnitude 5·3.

No. 684. γ AQUARII.—3-4 Sufi; 3 m. Ulugh Beigh, Tycho Brahé, and Hevelius; 3 m. Lalande; 3·88 Sir J. Herschel; 4·3 Argelander; 3-4 Heis; 3·9 Gould. Suspected variable by Sir W. Herschel, who says (*Phil. Trans.* 1796):—"48 (γ) is less than 62 (η), contrary to the Catalogue [Flamsteed's]; and is now probably less bright than it was formerly: 48 being but little brighter than 52 confirms the same. There is no observation of 48; but 62 is 5 m." As η was rated 4-3 by Argelander, and 4 m. by Heis, and Herschel says distinctly that γ was less than η, it seems highly probable that either

γ or η is variable to some extent. The Cordoba estimates make γ 0·2 m. brighter than η. Franks found $\gamma = \eta$ (= 4 m.), and both less than ζAquarii, Oct. 14, 1877. 4·07 H.P.

Sept. 10, 1883. I estimated γ as 4·0 from comparisons with ζ and η.

No. 685. Birmingham 610 Cephei.—7 m. Harding; 7·2 Argelander; 6·5 Schjellerup (No. 262); 6·5 Birmingham, March 19, 1873. In the notes to his Catalogue, Birmingham says, "on January 17, 1868, Secchi found this star very small, and suggested variability. On December 9, he searched twice, and found that the largest star on the field of view was no more than 8 mag." On February 17, 1884, I found it about 7½ m. with binocular.

No. 686. Anon Aquarii.—Observed by Rümker as 7·8 m., but not by Lalande or Bessel. Close to the place, Lalande and Bessel observed a 9 m. star, which seems to be Lalande 43873-4 (8½ and 9).

No. 687. ζ Piscis Australis.—5 m. Ptolemy; 5·6 Sufi; 6½ Lalande (43924); 6 m. Lacaille (9160); 6 Harding; 5-6 Argelander and Heis; 6-5 Behrmann; 7 m. *Cape Catalogue* (1878·72). It is included by Schönfeld in his provincial list of variables. He says (? quoting Schmidt), "August, 1864, und 1869, unter den günstigsten Umständen nur mit Mühe zu sehen, und selbst in dem hochgelegenen Kephissia nur 7 m. im Opernglas." A.N. 74·1770." From a discussion of the various magnitudes assigned by different observers, C. H. F. Peters comes to the conclusion (A.N. 2360) that this star is probably variable with a long period. 6·62 H.P.

I estimated it about 7 m. August, 1877 (Punjab), and November, 1882 (Ireland). Dr. Gould found it 6·6 or 6·7 from observations at Cordoba (*Uranometria Argentina*, p. 296).

No. 688. 67 Aquarii.—4 m. Ptolemy and Sufi; 6½, 7 Lalande (44433-4); 6 Harding; 6 m. Argelander and Heis; 6·4 Gould; 6 m. Franks, October 15, 1877. Sir W. Herschel gives 67·78. 6·20 H.P.

September 5, 1877, I found 67 less than κ Aquarii, and equal to a 7 m. (Harding) about 1° 20′ south of it.

No. 689. 66 (g) Aquarii.—6, 5, and 5½ Lalande (44436-8); 6 m. Harding; 5-6 Argelander and Heis; 5 Franks, 1877, and 1 mag. > 68. Sir W. Herschel gives 66 $\bar{,}$ 59 (v). The Cordoba estimates vary from 4·8 to 5·6, and Dr. Gould thinks it "probably variable" (*U. A.*, p. 310). 4·81 H.P.

No. 690. η Pegasi.—3 m. Ptolemy, Sufi, Lalande, Harding, Argelander and Heis; 3·31 Sir J. Herschel. In the *Monthly Notices* of the *R.A.S.*, January, 1874, Mr. Christie (now the Astronomer Royal) says, "there can be no doubt that η Pegasi is a new variable star of moderate period." Sir W. Herschel gives 55 (ζ), 62 (η) . 48 (γ). 2·95 Pritchard (1882·658). Schmidt thought its colour variable—more or less red in different years. 3·06 and 3·2 H.P.

No. 691. ξ PEGASI.—4-5 Sufi; 5 Lalande and Bessel; 4-5 Argelander and Heis; 4·8 in D.M. Sir W. Herschel gives 2 (ϵ) – 23 (ξ). 13 (ν); 4·6 Gould (at Albany), and 4·3 at Cordoba. Gould suspects variation. 4·62 Pritchard (1882·658). September 4, 1883, I estimated it two steps brighter than 55 Pegasi. 4·23 and 4·5 H.P.

No. 692. ϵ GRUIS.—4 m. Lacaille; 4-5 Behrmann; 4 m. *Cape Catalogue* (1876·72); 3·5 Gould, who says, there is some reason to suspect that it is "somewhat variable with a long period." The Cordoba estimates "showed a regular increase of brightness through each stage from 3·7 to 3·4."

No. 693. – 69 AQUARII.—5, $5\frac{1}{2}$, and 6 Lalande (τ^1) (44568-70); 5 m. Harding; 6 m. Heis; 5·8 Gould; 6 Franks. Gould marks it "red." 5·55 H.P.

December, 1875, considerably fainter than τ^2 (71) Aquarii.

September 6, 1877, I found this star equal to 74 and 77 Aquarii, but less than τ Aquarii (71 Fl.).

No. 694. – AQUARII.—A nebula discovered by Tempel, September 19, 1879, and suspected of variability from the fact of its having escaped detection by previous observers. He describes it as very little fainter than the nebula Herschel II. 744 (*Nature*, Nov. 20, 1879).

No. 695. ι CEPHEI.—4-3 Ptolemy, Sufi, and Argelander; 4 m. Harding; 3-4 Heis; 3·73 Sir J. Herschel (*Cape Observations*, p. 440); 4 m. Franks, October 13, 1877 (*private letter*). Schmidt considers this star to be variable with a period of 368 or $369\frac{1}{2}$ days. He found maxima, January 10, 1848; January 1, 1849; and January 15, 1850; and minima on July 30, 1848; July 18, 1849; and August 7, 1850. He compared the star with γ, but thinks it doubtful which is the variable (AN 1069); 3·61 Pritchard (1882). 3·62 and 3·8 H.P.

Sir W. Herschel found β – , ι. η, and 32 (ι) $\frac{•}{•}$ 3 (η).

In December, 1876, I found ι a little less than γ, and slightly less than ζ Cephei.

No. 696. γ (22) PISCIS AUSTRALIS.—6 m. Lacaille; 4–5 Argelander, Heis, and Behrmann. The Cordoba estimates vary from 4·5 to 5·0. In 1874 I found γ less than β, but brighter than δ.

No. 697. LALANDE 44782–4 PISCIUM.—7 and $7\frac{1}{2}$ Lalande; 8 m. Bessel; $6\frac{1}{2}$ Lamont; 8 in DM; 6–7 Heis, but found by Gould much below 7 m. He thinks it "not improbably variable" (*Uranometria Argentina*, p. 40).

No. 698. ρ PEGASI.—$5\frac{1}{2}$, 6 Lalande; 5 Harding; 5 Heis; 5·2 Gould; 5 Franks, October 14, 1877, "slightly brighter than σ" (*private letter*). Sir W. Herschel found 46 (ξ) – 50 (ρ), 49 (σ) and 50·31.

I found this star about half a magnitude brighter than σ Pegasi (5 m. Heis, and 5·3 Gould) on the following dates:—October 8, 1879; October 14, 1879; and three steps brighter on the following dates:—

September 18, 1881; and November 6, 1882. One of the two stars is possibly variable to a small extent.

No. 699. 45 Heis Lacertæ = 7995 B.A.C.—Suspected variable by Pierce, who says, "This is a reddish star, and there is a difference of 1·3 between the magnitudes of the *Uranometria* and *Durchmusterung*." It is 5 m. in *Lalande's Catalogue* (44897), and 7 m. in *Harding's Atlas*. Not in *Birmingham's Catalogue*. Pierce gives the following estimates of magnitude:—5·8 Argelander; 5–4 Heis; 4·5 DM; 5·16 Pierce. August 23, 1883, From comparisons with 3 and 5 Andromedæ, I estimated the mag. at 5·2 (or midway in light between 3 and 5). 5·17 H.P.

No. 700. 51 Pegasi.—5 m. Lalande (44894); 6 Harding. Sir W. Herschel gives 56–51, 60; 6–5 Heis; 5½ Franks, October 17, 1877 ("> 40, 41 or 45"), (*private letter*). 5·55 H.P.

September 10, 1883, I estimated this star at 5·8—brighter than 40, 41, or 45.

No. 701. Birmingham 625 Aquarii.—Secchi found this star "8 and 9 Dec., 1868, rose-coloured, and not full red—an undeniable change in the spectrum since last year" (*Notes to Birmingham's Catalogue*, p. 324).

No. 702. α Pegasi.—2–3 Sufi; 2 Argelander and Heis; 2·65 Sir J. Herschel (*Cape Obs.*, p. 440); 2½ Franks, Oct. 15, 1877. It has been suspected of variation (*Observatory*, April 1879, p. 420); 2·57 Pritchard (1882·895). 2·61 and 2·5 H.P.

No. 703. 55 Pegasi.—5 and 5½ Lalande (45214–5); 5 Heis; 5 Franks, October 29, 1877; 4·5 Gould. Sir W. Herschel gives 55, 59. The four stars 55, 57, 58, and 59 Pegasi, form a small trapezium a few degrees south of α Pegasi. I have observed the following sequences in these stars:—

October 8, 1879, order of brightness 55, 59, 58, 57.

September 18, 1881, order of brightness, 55, 59, 58, 57; 58 and 57 nearly equal, and 57 red.

November 6, 1883, order of brightness, 55, 59, 57, 58; 59 and 57 nearly equal, and 58 decidedly the faintest of the four; 57 orange, and about one and a-half steps brighter than 58.

September 4, 1883, sequence 55, 59, 57, 58. 55 is 4.65 in H.P.

No. 704. – 56 Pegasi.—5 m. Lalande (45224–5); 5 Heis; 5½ Franks (1877). Sir W· Herschel gives 62 (τ) – 56 – 51, and 56, 64.

September 10, 1883, I found 56 = o Pegasi, but one step less than τ Pegasi, or about 5 m. 4·89 H.P.

No. 705. – 57 Pegasi.—6 m. Lalande; 5–6 Heis; 5·4 Gould. Sir W. Herschel gives 58, 57. 5·45 and 4·9 H.P.

October 21, 1878. I found 57 less than 58 and 59.

October 8, 1879. 57 less than 58 Pegasi, but slightly brighter than 52 Pegasi.

September 18, 1881. 57 very slightly less than 58 Pegasi.

November 6, 1882. 57 about 1½ steps brighter than 58.

No. 706. 59 PEGASI.—5½, 6 Lalande (45383–5); 6–5 Heis; 5·4 Gould; 5 Franks (= 55 > 57), October 29, 1877 (*private letter*). (See note to 55 Pegasi). 5·12 and 4·8 H.P.

No. 707. ϕ AQUARII.—4½ and 5 Lalande; 4–5 Heis; 4·1 Gould; 5 Franks, October 29, 1877. Sir W. Herschel gives 93 (ψ^2)·90 (ϕ) -92 (χ), and 91 (ψ^1), 90 (ϕ). Schmidt and Gould call ϕ "red;" Birmingham, "Orange." 4·24 H.P.

No. 708. - 303 BODE AQUARII = LALANDE 45582 (6 m.) Included by Schönfeld in his provisional list. He says, "*U.N.* 6 m. 94 and 97 Aquarii ebenso. August, 1869, 5 bis 6 Stufen schwächer als beide und nur 7 m. Nach unbestimmter Erinnerung 1864 gleich hell mit 94" A.N. 74·1770 Auch Heis 6 m." It was estimated 6·6 m. at Cordoba, in 1872 and 1874, and 7 m. on the meridian in 1877 (*U. N.*, p. 310). 6·29 H.P.

No. 709. - 22743 A. O. AQUARII = LALANDE 45610 (7½). Included by Schönfeld in his provisional list. He says, "Wegen sehr verschiedener Grössenangaben der Cataloge von Schulhof untersucht und September 15, 1873 bis January, 1874, um $0^m 7$ zunehmend beobachtet; im Mittel etwa $7^m 2$, rothgelb. A.N. 83, 1981." It is not in *Birmingham's Catalogue of Red Stars*. It is 8 m. in *Harding's Atlas*, and is situated about 40′ *n. p.* 98 Aquarii. At Cordoba it was rated 7·6 in November, 1872, and 7·3 in August, 1877.

September 5, 1877. I found it equal to the star Lalande 45704 (8 m.), (which lies about 45′ *n. f.*).

No. 710. 8 ANDROMEDÆ.—5½ Lalande; 6 m. Groombridge; 5–6 Heis; measured 4·92 by Peirce (*Harvard Annals*, vol. ix). Sir W. Herschel found 7–8 , 11. It is a red star. In November, 1875, I found it slightly brighter than 7 Andromedæ; October 11, 1876, about half a magnitude less than 7, and slightly brighter than 11 ; November 3, 1878, half a magnitude less than 7, and a little brighter than 3 ; October 5, 1879, only very slightly, if at all less than 7—very reddish, with binocular, slightly brighter than 3 ; October 10, 1879, decidedly less than 7 ; about 0·3 m.—about 0·2 m. brighter than 11 ; September, 4, 1883, 8 about three steps less than 7.

No. 711. ψ^3 AQUARII.—Rated 4 m. by Ptolemy and Sufi; 6 Lalande; 5 Harding, Argelander, and Heis; 4·8 Gould; 5½ Franks, October 29, 1877; 5·3 Espin (September 2, 1880). Sir W. Herschel gives the sequence 94 , ψ^3 , 97. It is included by Schönfeld in his provisional list (Introduction to *Zweiter Catalog. von veränderlichen Sternen*, 1875). He says, "Der drei ψ Aquarii ist mir seit Jahren als veränderlich erschienen ; die Periode wird sehr lang sein A.N. 77, 1832." Dr. Gould, however, seems to doubt the variability (*U. A.*, p. 310).

No. 712. 8122 B.A.C. CEPHEI (= GROOMBRIDGE 4040).—6 m. Groombridge. Not in *Heis' Catalogue ;* 6 m. *Greenwich Catalogue.* Noted as variable by M. Liouville (*Comptes Rendus*, vol. xlii., 1856,

p. 546). He gives observations from 6 to 10 m., with a probable period of 115 days, "but very doubtful, owing to want of sufficient observations." I am not aware that the variation has since been confirmed. It is not in *Schönfeld's Catalogue*, 1875, but it has been lately suspected of variation by Franks, who rated it 7 m. in November, 1877, and "1^m < B.A.C. 8104." On February 22, 1884, I estimated it 7½ m.—more than a magnitude less than B.A.C. 8104, which seems about 6 m.; March 3, rather fainter about 7¾; March 13, small about 8 m.; March 14, 7¾ or 8 m.; March 17, 7¾; March 18, 8 m.; March 22, 8 m.

No. 713. Birmingham 637 Pegasi.—Not in *Lalande's Catalogue.* 7 m. Harding; 8·5 Lamont; 7 Bessel. Birmingham's observations (1873–1875) vary from 5 to 7·5; Webb, 8 m. December 12, 1873; Burton, not seen, September 26, 1876. My observations are:—

November 1, 1878, 7½ m.

December 23, 1878, a little brighter—about 7 m.

January 13, 1879, about half a magnitude brighter than a star *following* τ Pegasi.

August 14, 1879, about the same brightness as last observation.

September 13, 1879, about = a star *p* τ (3-inch refractor).

December 7, 1879, two steps brighter than the star *p* τ.

September 10, 1883, two steps brighter than the star *p* τ.

No. 714 - Cephei.—Variation suspected by Argelander, but not since confirmed.

No. 715. Lacaille 9455 Gruis.—5 Lacaille. The Cordoba estimates for the combined light of this star and Brisbane 7280 vary from 5·7 to 6·1 (*Uranometria Argentina*, p. 275).

No. 716. Lalande 45980 Aquarii.—7 m. Lalande, Piazzi, and Bessel; 6–5 Heis; 7·1 Johnson, 1858. Estimated 6·3 at Cordoba, 1872 and 1874, and 7½ on the meridian, November, 1877. Dr. Gould says, "Its variability seems probable."

No. 717. 100 Aquarii.—5 m. Lalande and Harding; 6–7 Heis. Not in Argelander's *Uranometria*, nor in Behrmann's *Atlas*; 6·3 Gould. Sir W. Herschel found 101 - 100. September 21, 1875, I found 100 much fainter than 99 and 101 Aquarii, and about magnitude 6½.

No. 718. Lalande 46090 Aquarii.—6½ Lalande; 6 Argelander and Heis, but found by Schmidt to be invisible without the telescope on July 9 and 10, 1878. It was rated 7 m. by Bessel and only 8–9 by Lamont. The Cordoba estimates are 6·7, 6·8, and 7·1.

September 21, 1879, I found it equal to a star closely *s.* of it - LL. 46085.

No. 719. ι Phœnicis.—5 m. Lacaille; 5–4 Behrmann. Gould says, "In 1871 the magnitude of ι Phœnicis was estimated as 5·1, but in 1873 it was 4·4, by the accordant estimates of two observers in each year."

No. 720. LACAILLE 9535 PHŒNICIS.—Dr. Gould thinks that this star has probably increased in light since the time of Lacaille, who rated it 5½ and 6. The Cordoba estimates were 4·3 to 4·6 (*U. A.*, p. 270).

No. 721. ι ANDROMEDÆ.—Rated 4–3 by Sufi; 4 m. and 5 m. by Lalande; 6 m. by Harding; 4 m. by Argelander and Heis; 7 m. by Piazzi; and 3–4 and 7 m. by d'Agelet. Sir W. Herschel found $\lambda - \iota, \kappa$. It was measured 4·44 by Peirce (*Harvard Annals*, vol. ix.). My own observations since May, 1875, show well-marked fluctuations in its light, to the extent of about half a magnitude. It is sometimes distinctly brighter than its neighbour, κ Andromedæ, and sometimes quite as distinctly fainter. The observations, however, do not seem to show any regular period. The star is usually about one or two steps less than κ Andromedæ, but I have seen it nearly three steps *brighter* than κ on several occasions during the years 1875–1884 (a step being about $\frac{1}{10}$ of a magnitude). Pritchard gives 4·58 (1882·677), κ being measured 4·34 on the same date. 4·30 and 4·1 H.P. (κ – 4·42 and 4·1).

No. 722. γ CEPHEI.—4 m. Ptolemy and Sufi; 3½ Lalande; 3–4 Argelander and Heis; 3·48 Sir J. Herschel. Sir W. Herschel found 35 (γ) – , β (or γ about ½ a mag. brighter than β); 3·51 Pritchard (1882·841. From comparisons with β Cephei in 1882 and 1883, Gemmill considers γ variable to a small extent. 3·37 and 3·5 H.P.

No. 723. 104 AQUARII.—4½ and 5 Lalande; 4 Heis. Sir W. Herschel found 104 = 103; 5·0 Gould. 4·78 H.P.

In December, 1875, and September, 1877, I found 104 brighter than 103.

No. 724. LALANDE 46442 PISCIUM.—7 m. Lalande; 6½ Bessel; 6·5 DM; 6–7 Heis; 5·9 Gould, who suspects variation, although he includes it in his Standards of Magnitudes (*U. A.*, p. 36).

No. 725. 8245 B.A.C. ANDROMEDÆ.—7 m. Lalande (46462); 6–7 Heis; 7 m. Franks, 1877.

No. 726. ω^2 AQUARII.—5 m. Ptolemy, Sufi, and Harding. Not in *Lalande's Catalogue*; 4–5 Argelander; 5 Heis. Sir W. Herschel ω^2, ω^1; 5 m. Franks (= ω^1), Oct. 29, 1877.

In December, 1875, and September, 1877, I found it brighter than ω^1 Aquarii (5–4 Heis).

No. 727. LALANDE 46504–8 PEGASI = 78 PEGASI.—Rated 4½, 5½, and 6 m. by Lalande; 5 m. Harding; 5 Heis; 4·93 H.P.

No. 728. 107 AQUARII.—6 m. Lalande and Harding; 5–6 Heis. Sir W. Herschel gives 106, 107, 108; 5·4 Gould. I found 107 equal to 106 Aquarii in Dec. 1875.

No. 729. 19 PISCIUM.—6 m. Lalande (46575); 5 Harding; 6·2 Argelander; 6 Heis; 6 m. Birmingham (No. 648), "red orange"), Sept. 17, 1873, and Sept. 16, 1876; 6 m. Franks ("fiery red"), Oct. 29, 1877.

The Cordoba estimates vary from 4·8 to 5·4, and Dr. Gould says, "The variability seems to me highly probable." Espin says, "The variation is undoubted, but the period may be long enough to enroll it in Class III." (Periods of several years), (*English Mechanic*, May 18, 1883).

No. 730. 80 Pegasi.—5½ and 6¼ Lalande (46719–20); 7 m. Harding; 6–7 Heis. Not in Argelander's *Uranometria*. Suspected variable by Gould, who rates it 5·8. Sir W. Herschel gives 77–80.

No· 731. 82 Pegasi.—6 m. Lalande (46772); 6 m. Bessel; 6·0 DM; 6–5 Argelander; 6 Heis; 5–7 Gould (at Albany), and 5·3 at Cordoba. Gould suspects variation, although he includes it in his list of standards of magnitudes (*U.A.*, p. 36). Sir W. Herschel gives 70, 82, 77.

No. 732. Birmingham 651 Cephei.—In the notes to *Birmingham's Catalogue* is the following remark, "No, 651 (Schj. 276), colour yellow, not red; very feeble zones; must be variable – Mem. II. orange, variable; third type; feeble zones—Prodromo, &c., 1876." Birmingham found it 7 m. and "yellow, slight red tinge," April 18, 1873.

No. 733. P. XXIII., 216, 217 Pegasi = Σ 3044.—A double star 8·5, 8·5 : 102° : 18″·5. Struve found the difference vary a whole mag., and Webb found the components obviously unequal, *p* the smaller." *Cel. Objects*, p. 369).

No. 734. Lacaille 9643 Centauri.—6¼ m. Lacaille; 6·0 Yarnall 1862); 6·7 Ellery (1867); 7–6 *Cape Catalogue* (1878–77). The Cordoba estimates vary from 5·5 to 6·2.

No. 735. Lalande 47032–34 Andromedæ.—Rated 7–8 m. by Lalande, Sept. 22, 1797, and 5–6 m. Nov. 11, 1798; 7 Harding. Labaume says (*R. A. S. Memoirs*, vol. iv.), that but for the difference of magnitude they might be considered identical. But as the positions given by Lalande agree closely, the star may possibly be variable. It was rated 6 m. by Heis (No. 41 of Andromeda), but is not in Argelander's *Uranometria*. It is a double star Σ 3050 (6, 6 : 202° : 3″) and a suspected binary.

Aug. 23, 1883, I found Heis' star (?) (the *f* of 3 stars in *Harding's Atlas*, Map xviii.) 4 steps brighter than Heis' No. 40 of Andromedæ (south of it); but query, Is Heis' star identical with the one referred to by Labaume? The star observed by me does not appear to be identical with Lalande's star, but is closely *following* it.

No. 736. 3 Ceti.—5½ Lalande (47200); 6 m. Heis; 5.22 H.P.

Dr. Gould remarks, "The Cordoba estimates of magnitude of this star range through the whole interval from 4·9 to 5·9, leaving, in my mind, small doubt of the variability of its light." Franks estimated it 5½ m. Oct. 29, 1877, and brighter than any of the following stars:—B.A.C. 8221, 8239, 8266, and 8285.

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Part 17.—Catalogue of the Earthquakes having occurred in Great Britain and Ireland during Historical Times; arranged relatively to Localities and Frequency of Occurrence, to serve as a Basis for an Earthquake Map of the Three Kingdoms. By JOSEPH P. O'REILLY, C.E., Professor of Mining and Mineralogy, Royal College of Science, Ireland. (Plate XI.) [September, 1884.]

Part 18.—Report on some recent Foraminifera found off the Coast of Dublin and in the Irish Sea. By FREDERICK PRYOR BALKWILL, and JOSEPH WRIGHT, F.G.S. (Plates XII., XIII., and XIV.) [March, 1885.]

Part 19.—On the Botany of Sinai and South Palestine. By H. C. HART, B.A. (Plates XV., XVI., and XVII.). [July, 1885.]

Part 20.—On Three Circles related to a Triangle. By W. S. M'CAY, M.A., F.T.C.D. [July, 1885.]

[*For continuation of List of Publications, see page* iii. *of this Cover.*]

XIX.—A CATALOGUE OF SUSPECTED VARIABLE STARS. WITH NOTES AND OBSERVATIONS. By J. E. GORE, M.R.I.A., F.R.A.S., Honorary Member of the Liverpool Astronomical Society.

NOTES ADDED IN THE PRESS.

(*March*, 1885.)

THE following notes contain further observations of some of the stars in the Catalogue up to the above date. My estimates of magnitude were made in the usual way by careful comparisons with neighbouring stars of nearly equal brilliancy. The magnitudes of the comparison stars were chiefly derived from the *Uranometria Argentina*:—

No. 4. LALANDE 405 CETI.—Jan. 6, 1885, I estimated it 6·6 m. A minimum was observed by Sawyer, December 4, 1884, mag. 7·0 or 7·1 (*private letter*).

No. 10. π ANDROMEDÆ.—Gage found this star constant at 4·3 from Sept. 13, 1883, to Jan. 20, 1884 (*Proceedings, Liverpool Astronomical Society*, Vol. II., p. 73), 4·39 H.P., and 4·6 "est."

No. 12. LALANDE 1013 CASSIOPEIÆ.—Feb. 5, 1885, fainter than the two stars *n.f.*

No. 16. 36 ANDROMEDÆ.—5·43 H.P., Nov. 7, 1884, about 6 m., and = ψ^2 Piscium.

No. 26. 37 CETI.—Feb 5, 1885, estimated 5·5 m.

No. 30. 43 CETI.—Nov. 12, 1884, estimated 6·8; Dec 21, 6·8.

No. 32. LALANDE 2598 CETI.—Nov. 12, 1884, 6·7; Dec. 21, 6·7.

No. 34. LALANDE 2798 CETI.—Nov. 12, 1884, about 8 m.; Dec. 21, below 8 m. This star seems certainly variable.

No. 39. 42 CASSIOPEIÆ.—5·07 H.P., Sept. 19, 1884; less than 46, but brighter than 43 Cassiopeiæ.

No. 48. 7 ARIETIS.—5·90 and 6·1 H.P. Oct. 22, 1884, 2 steps brighter than 1 Arietis; Feb. 14, 1885, one step *less* than 1 Arietis.

No. 54. 61 CETI.—6·02 H.P. Nov. 21, 1884, estimated 6·2.

No. 58. 66 CETI.—5·64 H.P.; 5·8 Gould. Nov. 21, 1884, estimated 5·4.

No. 60. LALANDE 4339 PERSEI.—Feb. 16, 1885, I estimated it 6·2 m.

No. 61. 740 B.A.C. Cassiopeiæ.—April 13, 1884, I found it faint with binocular; Sept. 13, 1884, faint with binocular in a clear sky; Sept. 18, faint; Nov. 7, faint; Nov. 24, faint; Jan. 6, 1885, about 8½ m.; Feb. 3, 8½ m.; March 12, 8¼.

No. 64. 79 Ceti.—Nov. 21, 1884, 7 m.

No. 66. Lalande 4864 Persei.—Feb. 5, 1885, estimated 6·5 m.; March 12, 1885, 6·4.

No. 78. Bradley 396 Cassiopeiæ.—Sept. 13, 1884, three steps brighter than 784 B.A.C.; Sept. 18, and Nov. 7, 1884, two steps brighter than 784; Nov. 24, one step brigher than 784; Jan. 6, 1885, one step *less* than 784; Feb. 3, one step less than 784 B.A.C.; Mar. 12, two steps less than 784 B.A.C.

No. 79. 5 Eridani.—5·38 H.P. Later observations by Espin show no variation.

No. 83. β Persei.—Franks found the companion "easy enough" with 11¼-inch reflector, Jan. 11, 1885, and about 2 magnitudes brighter than Burnham's faint companions.

No. 94. 30 (e) Tauri.—5·13 H.P. Nov. 9, 1884, 5·0; Dec. 21, 4·8; Feb. 3, 1885, 5·3.

No. 98. Lalande 7172 Tauri.—Nov. 9, 1884, about 8 m.; Dec. 21, 8·1; Feb. 3, 1885, 8·0.

No. 103. Lalande 7710 Persei.—Sept 18, 1884, about 6·2 m.—less than 56 Persei. 5·97 H.P.

No. 119. π' Orionis (1 Fl.).—3·33 and 3·6 H.P. From observations in 1883–84, Gage found a variation from 3·5 to 4·2, with a probable period of about 54½ days, and with minima on Nov. 30, 1883, and Feb. 22, 1884, and a maximum on March 21, 1884 (*Proceedings, Liverpool Astronomical Society*, vol. ii. p. 72).

No. 123. o' Orionis.—5·44 and 4·9 H.P. Dec. 23, 1884, estimated 5·1 m.

No. 135. λ Eridani.—Jan. 14, 1885, 4·8 m.

No. 137. II B. 16. Leporis.—5·86 H.P. Feb. 14, 1885, I estimated it 5·9 m.

No. 147. γ Orionis.—Gould at Albany found γ decidedly brighter than ϵ or ζ Orionis, whereas Thome at Cordoba found γ a ¼ magnitude *fainter* than ϵ or ζ.

No. 150. – ORIONIS—A 9-m. star (*f.* 31 Orionis) strongly suspected of variation by Argelander. Sadler has always failed to find any 9-m. star in or near the place (*English Mechanic*, March 8, 1878, p. 625).

No. 164. BIRMINGHAM 118 ORIONIS.—March 6, 1885, estimated 6·9 m.; March 9, 6·8.

No. 169. υ AURIGÆ.—5·20 and 4·8 H.P. April 11, 1884, 4·9; Feb. 3, 1885, 4·9; March 11, 5·0.

No. 170. 56 ORIONIS.—March 9, 1885, 5·1 m.

No. 172. π AURIGÆ.—April 11, 1884, 4·5; Feb. 3, 1885, 4·7 m. 4·47 and 4·7 H.P.

No. 173. LALANDE 11382 ORIONIS.—Jan. 6, 1885, 5·4; Feb. 3, 5·4; Feb. 14, 5·4; March 11, 5·5.

No. 174. 35 AURIGÆ.—Nov. 7, 1884, three steps less than 85 Heis Aurigæ.

No. 175. 39 AURIGÆ.—Not in the *Harvard Photometry*. April 26, 1884, four steps brighter than 38; Nov. 7, five steps brighter than 38; Nov. 23, six steps brighter than 38; Jan. 12, 1885, eight steps brighter than 38; Feb. 3, 1885, six steps brighter than 38; March 6, four steps brighter than 38.

No. 180. LALANDE 11884.—5·67 H.P. Nov. 27, 1884, estimated 6·1; Jan. 5, 1885, 5·7; Feb. 14, 1885, 6·0; March 14, 6·0 (H.P. scale).

No. 182. W.B. 265 ORIONIS.—Feb. 3, 1885, estimated 6·3 m.; Feb. 14, 6·1 m.; March 14, 6·3.

No. 183. LALANDE 12104 ORIONIS.—5·11 H.P. Feb. 5, 1885, 5·7 m.; March 12, 6·0.

No. 184. BIRMINGHAM 144 GEMINORUM.—Jan. 5, 1885, 6·6; Feb. 2, 1885, 6·8 m.

No. 186. BIRMINGHAM 147 MONOCEROTIS.—Feb. 5, 1885, estimated 7·7 m.; March 12, 1885, 7·6.

No. 187. 12 MONOCEROTIS. — 5·69 and 5·3 H.P. Feb. 3, 1885, 6·4 m.; March 11, 1885, 6·4.

No. 188. O. A. 5270. CANIS MAJORIS.—I could not see this star with the binocular in a clear sky, Feb. 14 and 16, 1885. It is not in Harding or Behrmann.

No. 193. - LALANDE 12788 MONOCEROTIS.—April 12, 1884, faint with binocular in a clear sky; Feb. 3, 1885, faint, about 8½ m.

No. 196. 33 GEMINORUM.—5·44 H.P.

No. 198. - LACAILLE 2470 CANIS MAJORIS.—6·53 H.P. Feb. 14, 1885, I estimated this star 7·2 m.

No. 203A. LALANDE 13627.—Measured 5·38 at Harvard. Jan. 6, 1885, I estimated it 6·0; Jan. 14, 5·9; Jan. 26, 5·9; Feb. 2, 6·0; Feb. 3, 6·0.

No. 205. 19 MONOCEROTIS.—4·82 H.P. March 23, 1884, 5·3; March 31, 5·5; April 1, 5·3; April 8, 5·5; April 12, 5·3; April 17, 5·3; Feb. 16, 1885, 5·5.

No. 208. δ CANIS MAJORIS.—1·85 and 2·2 "est" H.P.

No. 206. 2306 B.A.C. MONOCEROTIS.—5·20 and 5·6 H.P. April 12, 1884, estimated 5·6 m.

No. 212. 18 HEIS LYNCIS.—Feb 18, 1885, I estimated it 5·2 m.

No. 221. 61 GEMINORUM.—5·69 H.P. April 9, 1884, estimated 6·3.

No. 225. 65 GEMINORUM.—5·13 H.P. April 9, 1884, two steps brighter than 64.

No. 226. W. B. 669. MONOCEROTIS.—5·74 H.P. Feb. 3, 1885, estimated 6·1.

No. 234. U. CANIS MINORIS.—Baxendell finds variation from 8·5 to 13 m., with a period of 423 days. He gives its position for 1885, R.A. $7^h. 23^m. 27^s.5$, N. 8° 42′·9 (*private letter*, Oct. 1884). This star should be transferred to *Catalogue of Known Variables*.

No. 235. LALANDE 14970 CANIS MINORIS.—April 8, 1884, I estimated it 6·4, and Jan. 6, 1885, 6·4. Espin's observations, 1881–1884, vary from 6·55 to 6·3.

No. 242. STRUVE 1143 CANIS MINORIS.—Struve identified this star with L.L. 15179 (9 m.). Lalande's star lies $3^s.5$ *f.*, and 2′ 38″ *north* of the place given in the Catalogue, which is that of L.L. 15177 (*English Mechanic*, vol. XL., p. 493).

No. 243. BIRMINGHAM II. 36 GEMINORUM.—April 9, 1884, 6·1 m.; Feb. 4, 1885, 5·9.

No. 261. 30 Monocerotis.—3·86 H.P.; April, 11, 1884, 3·8 m.; February 14, 1885, 4·0.

No. 271. 52 Cancri.—April 11, 1884, about 7½ m.; February 16, 1885, 7½ m.

No. 272. 15 Hydræ.—5·49 H.P.; April 11, 1884, 5·85; April 12, 5·8; February, 14, 1885, 5·85.

No. 274. Birmingham 211 Cancri.—April 11, 1884, about 7 m., slightly brighter than two stars *n.p.*; February 16, 1885, 6½ m.—about half a magnitude brighter than the two stars *n.p.*

No. 275. 60 (a^1) Cancri = Birmingham 212.—5·70 and 5·5 H.P.; April 11, 1884, one step brighter than 50 Cancri.

No. 280. Lalande 18044 Cancri.—April 9, 1884, I estimated it 6·4; about equal to 66 Cancri.

No. 284. 3180 B.A.C. Argûs.—Found faint at Harvard.

No. 287. α Hydræ.—2·02 and 2·3 H.P. On April 9, 1884, I estimated this star only ¼ magnitude less than Regulus. (α Leonis.)

No. 288. ξ Leonis.—5·20 and 5·5 H.P. April 12, 1884, I estimated it 5·7; April 19, 5·6; April 26, 5·6; May 11, 5·5; February 5, 1885, 5·6; March 12, 5·6.

No. 289. 3245 B.A.C. Ursæ Majoris.—November 12, 1884, two steps less than the star *s.f.*; January 12, 1885, same as last observation.

No. 292. ι (35) Hydræ.—4·15 H.P.; April 11, 1884, estimated 3·85—half a step less than θ Hydræ.

No. 295. ψ Leonis.—5·66 and 6·0 H.P.; May 12, 1884, 5·9 m.; May 17, 6·1; February 5, 1885, 5·9.

No. 297. 12 Sextantis.—6·65 and 6·4 H.P. February 14, 1885, I estimated it 6·7 m.

No. 324. 2543 R. Ursæ Majoris.—September 17, 1884, 6·2; October 2, 6·3; October 10, 6·2; November 12, 6·2.

No. 344. Lalande 21860 Leonis.—March 6, 1885, estimated 6·6 m.

No. 345. λ Draconis.—4·09 and 4·1 H.P.

No. 375. β CORVI.—Sawyer finds a variation of about one mag. in this star (*private letter*).

No. 383. BIRMINGHAM 290 CANES VENATICI.—Called by Schjellerup "La Superba." Estimated 5·3 by Gage, June 15, 1884 (*English Mechanic*, August 1, 1884); 5·59 and 5·9 H.P.

No. 384. LALANDE 23824 VIRGINIS.—April 26, 1884, estimated 6·3 —one step brighter than LL 23410, but about half a magnitude less than 31 Virginis.

No. 412. 83 URSÆ MAJORIS.—April 8, 1884, I found it one step less than Alcor (80); February 26, 1885, three steps less than Alcor; March 6, three steps less than Alcor.

No. 417. ν BOOTIS.—4·11 H.P. May 28, 1884, half a magnitude brighter than τ Bootis—strong twilight.

No. 426. 15 BOOTIS.—5·23 and 5·4 H.P. May 28, 1884, estimated 5·8. Espin's observations, 1882–1884, show no variation (*private letter*).

No. 428. W.B. 143 VIRGINIS.—6·07 H.P. April 20, 1884, estimated 6·2—equal to LL 26056.

No. 431. ν VIRGINIS.—5·19 H.P. April 20, 1884, estimated 5·7.

No. 433. 103 (ν^2) VIRGINIS.—6·67 H.P. April 20, 1884, 7·0—less than LL 2627 3.

No. 436. BIRMINGHAM 327 BOOTIS.—Espin found the light of this star constant at 6·8–7·0 in 1882–1884 (*private letter*).

No. 440. ϕ VIRGINIS.—4·89 H.P. April 20, 1884, estimated 5·2.

No. 443. π BOOTIS.—4·59 H.P. April 8, 1884, $\pi = o$ Bootis; May 6, 1884, π one step less than o, strong twilight; May, 28, 1884, π one step brighter than o.

No. 446. 31 BOOTIS.—4·99 H.P. May 28, 1884, estimated 5·0. Espin's observations, 1881–1884, show a difference of only 0·3 mag. (*private letter*).

No. 447. 34 BOOTIS.—April 10, 1884, 4·8. 4·93 H.P.

No. 451. LALANDE 27017 BOOTIS.—7·02 H.P. and 6·5 "est." April 20, 1884, estimated 6·8—two steps less than LL 26312.

No. 452. LACAILLE 6077 APODIS.—Gould says "the variability seems beyond question."

No. 460. δ BOOTIS.—3·50 H.P. March 23, 1884, 3·7; April 10, 3·6; March 21, 1885, 3·6.

No. 461. STRUVE 1932 CORONÆ.—March 12, 1885, estimated 6·3. This star seems certainly variable; March 21, 6·4.

No. 472. μ CORONÆ BOREALIS.—5·44 and 5·1 H.P.; March 21, 1885, 5·3.

No. 474. Σ 1964 CORONÆ BOREALIS.—April 19, 1884, I estimated it 7·2—equal to LL 28641 (*n.f.* ζ), but less than LL 28347; September 21, 1884, 6·9—three steps *brighter* than LL 28641; March 9, 1885, one step brighter than LL 28641. Burnham rated the components 8·0 and 8·2 (1880·392).

No. 479. LALANDE 28716 SERPENTIS.—April 20, 1884, considerably less than λ Serpentis; May 2, 1884, less than ω Serpentis, and about equal ψ (6·2 Gould).

No. 481. 5248 B.A.C. DRACONIS.—6·03 H.P. and 5·4 "est."

No. 494. BIRMINGHAM 372 SERPENTIS.—Found at Dunsink to have no colour on April 30, 1880, and deep orange (!) on June 10.

No. 498. W.B. 140 SCORPII.—5·98 H.P.

No. 500. LALANDE 29822 OPHIUCHI.—September 21, 1884, 7·3 m.

No. 501. χ OPHIUCHI.—5·03 H.P.

No. 505. β HERCULIS.—2·76 H.P. May 17, 1884, estimated 2·5—one step brighter than ζ Herculis.

No. 508. 33 HERCULIS.—May 12, 1884, 7·1 m.

No. 509. 17 DRACONIS.—5·24 and 4·8 ("est") H.P.

No. 511. ι OPHIUCHI.—4·41 and 4·2 H.P. May 2, 1884, I found this star considerably fainter than γ Serpentis (3·83 Pritchard; 4·00 H.P.) and about equal ω Herculis (4·8 Gould; 4·69 H.P.); May 12, 1884, one step brighter than ω, or 4·7 m.

No. 513. 24 OPHIUCHI.—5·55 H.P.

No. 515. 30 OPHIUCHI.—September 20, 1884, 5·6 m. 4·98 H.P.

No. 518. μ DRACONIS.—5·18 H.P.

No. 526. σ OPHIUCHI.—4·42 and 4·7 H.P. May 19, 1884, estimated 4·4—equal to 70 Ophiucii, and reddish; May 22, 4·5.

No. 527. 51 (c) OPHIUCHI.—4·88 H.P.

No. 532. BIRMINGHAM 420 OPHIUCHI. — September 20, 1884, invisible with binocular.

No. 534. BIRMINGHAM 422 OPHIUCHI.—September 20, 1884, 7½ m.

No. 536. D.M. 45°, 2627.—April 10, 1884, 6·9; September 13, 6·8.

No. 537. 68 Ophiucii.—Measured 4·75 at Oxford (1882·483); 4·42 H.P. May 19, 1884, four steps less than 67 (*o*) and 70 Ophiucii; May 22, 1884, and September 20, 1884, same magnitude.

No. 539. γ Sagittarii.—3·05 H.P.

No. 548. – η Serpentis.—3·35 H.P. September 21, 1884, 3·5 m.—equal to ν Ophiucii.

No. 551. 42 Draconis.—4·98 H.P.

No. 554. α Scuti.—4·01 H.P. September 20, 1884, estimated 4·2.

No. 557. Lalande 34746 Aquilæ.—September 20, 1884, estimated 7·7 m.

No. 559. 29 Sagittarii.—5·49 H.P.

No. 560. Birmingham 464 Aquilæ.—September 20, 1884, I estimated it 8 m. It was estimated 8 m. by Gemmill, August 20, 1884.

No. 561. Lalande 35150 Serpentis.—6·01 and 6·3 H.P. May 27, 1884, 6·5; September 13, 6·5.

No. 564. 11 Aquilæ.—5·20 and 5·3 H.P. May 27, 1884, 5·8 m.; September 13, 5·8.

No. 566. 12 Aquilæ.—4·02 H.P. September 19, 1884, estimated 4·2—three steps brighter than 6 Aquilæ.

No. 567. λ Lyræ.—5·12 and 5·3 H.P.

No. 568. Birmingham 483 Aquilæ.—Gemmill estimated this star 8·5 m., August 19, 1884, and 8 m. September 2, 1884.

No. 574. Lalande 36099 Aquilæ.—6·34 H.P. September 17, 1884, 6·6 m.

No. 575. 53 Draconis.—5·19 H.P.

No. 577. 24 Aquilæ.—September 19, 1884, about 7 m.—slightly brighter than the star north of it, but at least one magnitude fainter than 27. 6·59 and 6·2 H.P.

No. 579. 6624 B.A.C. Lyræ.—April 19, 1884, I estimated it 7·2—equal to Lalande 36561, but considerably brighter than Lalande 36527 (*s.f.*); September 18, 1884, 7·3.

No. 580. χ^3 Sagittarii.—5·87 H.P.

No. 584. LALANDE 36781 AQUILÆ.—6·17 and 5·8 H.P. May 27, 1884, 6·8; September 13, 6·7.

No. 585. α VULPECULÆ.—4·69 H.P.

No. 586. LALANDE 36863 AQUILÆ = P. XIX., 144.—September 17, 1884, 6·8 m.

No. 587. 36 (e) AQUILÆ.—5·23 H.P. September 21, 1884, estimated 5·6 m.

No. 590. D.M. 17°, 3997.—S. C. Chandler, Jun., considers that d'Agelet's star is *not* identical with the *Durchmusterung* star. He failed to see any trace of a star in d'Agelet's position (0ˢ·7 *f.*, and 2′·2 *n.* of the D.M. star) with a 6¼-inch reflector in 1882 and 1883, and found it invisible with 15-inch refractor, November 4, 1883 (*Science Observer*, 43·44, vol iv.). On September, 18, 1884, I could see no trace of the star with the binocular in a clear sky.

No. 591. μ AQUILÆ.—4·68 and 5·2 H.P.

No. 595. 6728. B.A.C.—Nov. 25, 1878, I found this star less than LL 37237 (*n.p.*), but brighter than LL 37436 (*n.f.*); Oct. 22, 1884, two steps less than LL 37237.

No. 598. D.M. 41°, 3469 CYGNI.—6·07 H.P. Oct. 10, 1884, three steps brighter than the star near 14 Cygni; Oct. 22, 1884, six steps brighter than the star near 14; Feb. 5, 1885, six steps brighter than the star near 14.

No. 599. LALANDE 37621 CYGNI.—Nov. 19, 1883, less than LL 37783, but brighter than LL 37674; Oct. 22, 1884, same as last observation.

No. 602. π AQUILÆ.—5·70 and 5·9 H.P.

No. 604. LALANDE 37868.—Sept. 21, 1884, about 6 m.; two steps less than LL 37960; 5·76 H.P.

No. 605. 9 SAGITTÆ.—May 28, 1884, 6·8 m.; Sept. 21, 6·6—at least one magnitude less than ζ Sagittæ.

No. 606. ϵ DRACONIS.—3·93 H.P. April 20, 1884, 4·1; Feb. 16, 1885, 4·0.

No. 608. 10 SAGITTÆ.—May 28, 1884, half a magnitude less than 11, or 6·5 m.; Sept. 21, 1884, 6·6.

No. 609. η CYGNI.—4·04 and 4·2 H.P. Nov. 9, 1884, I estimated it three steps brighter than 8 Cygni.

No. 611. Lalande 38405 Aquilæ.—Sept. 17, 1884, 6·8 m.

No. 613. Lalande 38506 Aquilæ.—6·44 H.P.

No. 614. 66 Aquilæ.—5·74 H.P. Sept. 17, 1884, estimated 6·1, and equal 62 Aquilæ.

No. 615. Lacaille 8381 Sagittarii.—5·97 H.P.

No. 622. Lalande 39222 Aquilæ.—6·09 H.P. Sept. 17, 1884, I estimated it 6·3.

No. 623. Birmingham 558 Delphini.—Sept. 17, 1884, 6·3 m.

No. 625. Anon Capricorni.—Sept. 13, 1884, much less than LL 39361 (7·6 Gould).

No. 628. ω^3 Cygni.—5·57 H.P.

No. 630. 47 Cygni.—Sept. 19, 1884, two steps less than λ, but brighter than 49 Cygni. 4·77 H.P.

No. 633. ι Delphini.—5·30 H.P.

No. 634. 71 Aquilæ.—4·44 H.P. Sept. 18, 1884, estimated 4·3.

No. 635. Red Star near α Cygni.—Baxendell's observations show this star to be certainly variable (*private letter*, Oct., 1884). Its designation will be V Cygni.

No. 636. Birmingham 569 Delphini.—Estimated 7·5 by Espin, June 28, 1884, and 6·3 m. July 23, 1884 (*private letter*). Sept. 13, 1884, I estimated it 6·7; Sept. 17, 6·9; Sept. 18, 6·9; Oct. 10, 7·2; Oct. 22, 7·3; Oct. 24, 7·1; Nov. 5, 6·7; Nov. 7, 6·8; Nov. 9, 6·7; Nov. 21, 6·6; Nov. 24, 6·5; Dec. 3, 6·5; Dec. 14, 6·4; Dec. 17, 6·4; Dec. 21, 6·5; Jan. 5, 1885, 6·7; Jan. 8, 6·9. This star is certainly variable.

No. 640. 14 Delphini.—6·14 and 6·3 H.P.

No. 664. 7489 B.A.C. Cygni.—April 19, 1884, 6·8 m., two steps less than LL 41949 (*n.p.*); Sept. 18, 6·8; 6·22 H.P.

No. 664a. Birmingham 587 Cygni = D.M. 44°, 3877.—Sept. 18, 1884, about half a magnitude less than LL 42205; Nov. 7 and 9, equal to LL 42205; Nov. 21, about 6·3, and one step brighter than LL 42205; Dec. 14 and 17, same as last observation; Dec. 23, 1884, two steps brighter than LL 42205; Jan. 5, 1885, about 5·8; Jan. 12, 1885, 5·9; Jan. 26, 6·3; Feb. 2, 6·7; Feb. 7, 6·8; Feb. 13, 6·8; Feb. 16, 6·8; Feb. 22, 6·7; March 6, 6·7. This star seems certainly variable. Peirce says the star observed by him "was perhaps DM + 45°, 3637," which is identical with LL 42376 (*n.f.*).

No. 665. 41 CAPRICORNI.—5·17 H.P.

No. 669. BIRMINGHAM 596 AQUARII.—Sept. 18, 1884, about 7½ m., only a little brighter than the star *s.f.*

No. 670. 28 AQUARII.—5·81 H.P.

No. 697. LALANDE 44782 PISCIUM.—Sept. 17, 1884, estimated 7·0 m. and = LL 45030; Nov. 7, 1884, 7·1 m.

No. 698. ρ PEGASI.—4·95 H.P.

No. 710. 8 ANDROMEDÆ.—4·87 H.P.—Sept. 18, 1884, two steps less than 7, and three steps brighter than 11 Andromedæ. Feb. 14, 1885, two steps less than 7.

No. 711. ψ^3 AQUARII.—5·08 H.P.

No. 712. 8122. B.A.C. CEPHEI.—(Liouville's variable). April 2, 1884, about 8 m.; April 13, 8 m.; April 17, 7¾; May 12, 7¾; Nov. 7, 7½.; Jan. 15, 1885, 7½; March 11, 7½.

No. 718. LALANDE 46090 AQUARII.—6·67 H.P.

No. 724. LALANDE 46442 PISCIUM.—Sept. 18, 1884, estimated 5·9; Nov. 12, 6·1.

No. 725. 8245 B.A.C. ANDROMEDÆ.—Gage found this star constant at 6·3 from Sept. 13, 1883, to Jan. 26, 1884 (*Proceedings, Liverpool Astronomical Society*, vol. II., p. 73).

No. 726. ω^2 AQUARII.—4·68 H.P.

No. 729. 19 PISCIUM.—5·15 and 5·7 H.P. Espin's observations (1880–1884) show a variation from 5·2 to 6·2, and he deduces a period of 165 ± days, with a maximum 1884, Aug. 19, at which epoch the maximum (5·2 m.) was "very marked" (*private letter*). On Sept. 17, 1884, I estimated it 5·5. This star should be transferred to *Catalogue of Known Variables.*

No. 730. 80 PEGASI.—6·02 H.P. Sept. 18, 1884, estimated 6·3; Nov. 12, 6·4.

No. 731. 82 PEGASI.—5·32 and 5·5 H.P. Sept. 18, 1884, 5·2 m.; Nov. 12, 5·2.

No. 735. LALANDE 47032 ANDROMEDÆ.—5·77 H.P.

No. 736. 3 CETI.—Feb. 4, 1885, I estimated it 5·4 m.

SUPPLEMENTARY LIST.

No.	Star.	R.A., 1880.	Declination, 1880.	Supposed Change of Magnitude.	Authority.
		H. M. S.	° ′		
737	Lalande 47304 Ceti, . .	0 1 36	− 23 11	5·9 to 7·8	Gore.
738	— Piscium, . . .	0 37 46	+ 6 38	9 to 12	Hind.
739	— Tauri, ...	3 37 53	+ 9 1·2	9½ to 0	Palisa.
740	— Tauri, ...	4 32 45	+ 13 29·1	9½–0	Palisa.
741	Birmingham 96 Orionis, .	4 59 12	+ 1 0·7	6–8	Gore.
742	μ Aurigæ, ...	5 5 13	+ 38 21	. .	Espin.
743	Aurigæ, . . .	5 13 24	+ 41 41	. .	Espin.
744	31 Orionis (comes), . .	5 23 38	− 1 11·2	Comes var.	Sadler.
745	Near θ Orionis (Bond 654), .	5 29 57	− 5 28	11·5–0	
746	— Orionis, ...	6 11 29	− 1 31·7	8–9½	Copeland.
747	— Monocerotis, . . .	6 16 41	− 2 8	7–10	Schönfeld.
748	15 Monocerotis, . . .	6 34 23	+ 10 0	Comes var.	
749	— Geminorum, . . .	6 59 40	+ 28 5·5	9–12	Safarik.
750	— Cancri, ...	8 0 2	+ 23 8	9½–?	Palisa.
751	— Cancri, ...	8 21 19	+ 8 59	9½–?	Palisa.
752	D.M. 33°, 1895, Leonis Minoris,	9 33 37	+ 33 32·4	6·8–7·7	Espin.

754	— Leonis, ...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
755	16 (*c*) Virginis, . . .	12	14	18	+ 4	0	4–5½	Baron de Zach.
756	Struve 1647 Virginis, . .	12	24	30	+ 10	23	. .	Struve.
757	1902 Carrington, . . .	12	44	49	+ 82	20	8–10½	*Nature*. (See note e).
758	— Virginis, ...	13	48	2	+ 11	39·6	8½–?	Hind.
759	36 Ophiucii, ...	17	8	0	− 26	25	. .	
760	π Herculis, ...	17	10	54	+ 36	56	3 to 3½	Gore, 1884.
761	ψ Draconis, ...	17	44	6	+ 72	13	Slight var.	Gemmill.
762	95 Herculis, . . .	17	56	24	+ 21	36	4–5	
763	o Herculis, ...	18	2	54	+ 28	45	⅓ mag.	S. C. Chandler. Schwab.
764	— Draconis, . . .	18	9	45	+ 71	3·2	9–?	Schmidt.
765	Birmingham 458 Lyræ, .	18	38	40	+ 38	51	7·5–9	
766	σ Lyræ, ...	18	50	28	+ 33	49	Comes var.	O. Struve.
767	Σ 3130 Lyræ, . . .	18	52	20	+ 44	4	Comes var.	
768	Lalande 37393 Aquilæ, . .	19	35	32	+ 12	53·4	6½–9½	Argelander.
769	— Cygni, ...	19	38	8	+ 35	56	8½–10	Argelander.
770	δ Cygni, ...	19	41	12	+ 44	50	Comes var?	Struve.
771	Lalande 40728 Cygni, . .	20	56	33	+ 39	47	. .	Espin.
772	Birmingham 598 Cygni, .	21	50	40	+ 49	56·5	9–?	Birmingham.
773	P XXIII, 100, 101 Cassiopeiæ,	23	24	29	+ 57	53	Comes var.	

NOTES AND OBSERVATIONS.

No. 737. (= LACAILLE 9732).—6½ Lalande and Lacaille; 6 Harding; not given by Argelander or Heis; 6 m. Behrmann; estimated 5·9 m. at Cordoba; but measured only 7·29 at Harvard (H.P. 2).

No. 741. B 96.–6½ and 7 LALANDE (9581–2); 6 and 7 m. Birmingham; 8 Webb; 6·6 Gould; March 9, 1885, estimated 7·0.

No. 742. Not mentioned by Sufi; 5 m. Lalande; 6–5 Heis; 4·92 and 5·1 H.P. On April 13 and 20, 1884, I found $\mu = \lambda$ Aurigæ, and 1 step brighter than σ; Sept. 13, $\mu = \lambda$.

No. 743. 6 m. Heis; 5·38 Peirce; 5·14 H.P.; and 5·8 "est."

No. 744. A companion to this star (86°·5 : 12″·12) is suspected of variation.

No. 748. 15 MONOCEROTIS.—A companion to this known variable star (139°·2 : 75″·7) has been suspected of variation. It was estimated 8·5 m. by Main (1863·16), but only 12 m. by Sadler (1875·3).

No. 752. March 25, 1884, equal to its neighbour D.M. 33°, 1898, or 6·8 m., but in a photograph taken by Espin on May 19, 1884, only 7·7 m. "A third photograph was taken a few nights later, when the star had apparently regained its previous brilliancy." It is Lalande 18957 (8 m.). Not in *Harding's Atlas.*

No. 755. 4 m. Lalande (25113); 5 Harding; 5 Heis; 5·5 Gould; 5·15 and 5·3 H.P.

No. 756. A double star; relative brightness of components variable according to Struve.

No. 757. *Nature*, June 5, 1884. Position for 1885·0.

No. 759. A well-known double star; one of the components probably variable (see *Southern Stellar Objects*, p. 64).

No. 760. 4–3 Sufi; 3–4 Argelander; 3 Heis and Houzeau; 3·0 D.M.; 3·60 Pritchard (1882·376); 3·36 and 3·2 H.P. June 6, 1875, I found π about equal to ζ Herculis; Sept. 22, 1875, π distinctly brighter than ϵ, but not quite equal to ζ Herculis.

No. 761. 4·84 Pritchard (1882·731); 4·52 and 4·3 H.P. I found it = τ Draconis, March 4, 1884.

No. 762. 5¼ Lalande (33087–8); 5 Harding; 5–4 Heis; 4·25 at Oxford (1882·398); 4·55 and 4·8 H.P. A well-known double star. Struve rated the components at 4·9 each, and Smyth 5½ and 6. Variation has also been suspected in the colours of the components. May 23, 1884, I estimated 95 one step less than 102, but considerably brighter than 96 Herculis.

No. 763. 4 m. Lalande; 4 Heis; 3·67 at Oxford (1882·398); 3·99 H.P. May 23, 1884, I found it one step less than ξ Herculis.

No. 765. = Arg. 36°, 3243.

No. 766. A close companion (126°·9: 1″·84) is suspected variable; 8 and 9 m. Dembowski; 11 m. O. Struve. Burnham found it "very difficult" with 6-inch refractor.

No. 768. No magnitude given in Lalande; 8 m. Harding.

No. 770. A well-known double star. The small companion suspected of variation by Struve, Dembowski, and O. Struve.

No. 771. Sept. 17, 1884, I estimated it 6·8 m.

No. 772. Birmingham's observations vary from 9·5 m. to invisibility.

No. 773. One of the components of this multiple star—*h* 1886—has a small companion, which has been suspected of variation; 13 m., Sir J. Herschel; 14 m., Smyth; 16 m., Piazzi Smyth at Teneriffe (Herschel's scale); 10·5 m. Sadler.

XX.—Report on the Botany of Lough Allen, and the Slieveanierin Mountains. By Samuel Alexander Stewart, Fellow of the Botanical Society of Edinburgh, Curator of the Collections in the Museum of the Belfast Natural History and Philosophical Society.

[Read, January 26, 1885.]

Lough Allen may be reckoned amongst the principal Irish lakes. Its general form is somewhat pear-shaped, the extreme length from north to south being nine miles, the breadth varying from three miles at the north to less than one mile at the southern end. The lough is shut in, on the east side, by the Slieveanierin range of mountains, the highest point being Slieveanierin, in the county Leitrim, 1922 feet. Slievenakilla, which is on the boundary of the counties Cavan and Leitrim, has an elevation of 1793 feet. On the west side the lough is bounded by the low hills of the Arigna range, which lie in the counties of Cavan and Roscommon. On this side the slopes rise steadily for a distance of one to two miles from the shore, and culminate in a ridge, the highest points of which are over 900 feet. The surface of the lake has an elevation of 160 feet above the sea. At the extreme north the Upper Shannon pours into the lough, from the county of Cavan, as a rapid, though unimportant mountain stream. Here it is augmented by the numerous rivulets which drain the surrounding hills, so that it flows out at the south, near Drumshambo, as a deep but rapid river. At Ballantra, at the margin of the lake, is the old Shannon Bridge, over which the French forces under General Humbert passed in 1798, and which they ineffectually endeavoured to blow up in order to prevent pursuit. The damage thus done was not repaired, but a new road and new bridge being constructed, the old bridge has been allowed to remain in its dilapidated state, an object of greater interest than the much better modern structure. The violence of the wind is often severely felt on Lough Allen, and the occasional squalls which surge through the narrow passes of the encircling hills are sometimes dangerous. The extent of the district now reported on is, roughly stated, twelve miles in length, and six in breadth, an area of some seventy-two miles, about one-fourth of which is under water. A very large percentage of the land is occupied by boggy heaths, and another large portion by wet pastures. A comparatively small part is in tillage, and this mainly around the margins of the lake. To the south, near Drumshambo, limestone rocks predominate, and afford a better soil. The mountain streams have cut deep gorges in the hills, forming gloomy ravines, whose sides alternate with wet sandstone ledges, and black crumbling shales, and are but slightly relieved by displays of wild flowers, or of graceful native shrubbery. Unless for the sportsman, the scene is uninviting in the extreme, and little pains are taken by the people to improve it. Only in rare in-

stances is there any attempt to ornament the cottages by even the simplest flowers.

The entire district is included in the Connaught coal-field, one of the few tracts of coal-measures which remain in Ireland. The rocks composing the strata lie far down in the Upper Carboniferous series; they rise on the east side to an elevation of nearly 2000 feet. These mountains are considered by the officers of the Geological Survey as of the age of the English Yoredale beds, and therefore at the base of the Upper Carboniferous, and in immediate succession to the great mountain limestone series, so well developed in the Ben Bulben range to the north-west. The strata are well exposed in the admirable section made by the Stony River, which in rainy weather rushes down the west side of Slieveanierin as a mountain torrent. Massive beds of what seems a valuable hæmatite are interstratified with soft black shales, and occasional bands of sandstone. These beds are dominated by sandstones that appear in low cliffs as tabular masses, and are referred by Professor Hull to the millstone grit. The elevated plateau thus constituted was at one time continuous over a wide area, extending, as we still see, across Cavan to Fermanagh on the east. The action of denuding agencies, persistently operating for long periods, has resulted in sculpturing the surface into its present outline, and thus we have now the Slieveanierin, and Cuilceagh ranges, and their subordinate hills, separated by broad valleys and deep glens excavated in the underlying shale. At the south end of Lough Allen there is a small exposure of mountain limestone rocks, on which flourish several plants not met with elsewhere in the district. The rocks forming the low hills on the west of the lough are classed as equivalents of the lowest coal-measures of England, and contain thin seams of indifferent coal. In several places this coal is extracted in small workings of a most primitive character.

On the Arigna river, three and a-half miles north-west of Drumshambo, are extensive iron-works, but out of use for half a century, and now in a state of dilapidation, heaped up with rubbish, and overgrown with weeds. Stores of valuable metal are all around, and, if coal suitable for smelting could be obtained, there is no reason why these old buildings should not be replaced by still more extensive works. A district, with rocks such as those just described, nowhere presents a variety of vegetation, or yields plants of much rarity. But, as our uplands have an altitude almost equal to that of the Ben Bulben range, only some twenty-five miles to the north, it might nevertheless reasonably be hoped that some of the rarities of that famous botanical region would extend to these neighbouring hills. Such is not the case, and the result of the present exploration is still further evidence as to how profoundly the flora of a country is controlled by petrological conditions. It is further to be remarked that this region, now so bare, was at one time well wooded, and that the flora has responded to the changed conditions, so that sylvan plants are at present extremely scarce. The list which follows includes only plants which were

actually seen. A few, doubtless, were overlooked, and a very few of the plants of early spring were missed; but it is not allowable to assume their occurrence, even though they be of the commonest types. The whole number of species now put on record is 364, namely, flowering plants 269, ferns and their allies 20, characeæ 3, mosses 64, hepatics 8. The enumeration of the two latter groups is not to be considered as at all complete, the hepaticæ not being specially sought for, and the mosses which appear in winter remain unnoted. This flora belongs almost entirely to District IX. of the *Cybele Hibernica*, and this being one of the best worked districts, but few new discoveries could be made. The following, however, have not hitherto been published in any list of plants in District IX., namely:—

Medicago lupulina.	Myriophyllum spicatum.
Rubus leucostachys.	Ægopodium podagraria.
R. hirtifolius.	Arctium minus.
R. villicaulis.	Carex aquatilis.
R. macrophyllus.	Equisetum maximum.
R. kœhleri.	Isoetes lacustris.
R. lejeunii.	

The grouping of the species in the following list amongst the larger orders of British plants shows considerable differences when compared with the general flora of Ireland. Some orders have a representation much in excess of what they could claim, if this florula were constituted similarly to the flora at large; the most marked of these being the Compositæ, Scrophulariaceæ, and Juncaceæ. Of the latter order this small district yields two-thirds of the species represented in Ireland; rushes are everywhere, and in an abundance which certainly is not exceeded in any other part of the country. To balance this preponderance of some orders, it will be observed that there is a corresponding deficiency in others, notably the Cruciferæ, Labiatæ, Orchidaceæ, and Filices.

Regarding the geographical relations of this flora, it will be seen that Watson's British type claims the great mass of the vegetation, the exceptions being few in number, confined to very narrow limits, and nowhere occurring in abundance. Of Watson's English type only twenty can be enumerated, namely:—

Nuphar lutea.	Carduus pratensis.
Nasturtium palustre.	Scrophularia aquatica.
Armoracia amphibia.	Lysimachia vulgaris.
Hypericum androsæmum.	Habenaria chlorantha.
Trifolium minus.	Juncus glaucus.
Lythrum salicaria.	Carex stricta.
Cicuta virosa.	Trisetum flavescens.
Pulicaria dysenterica.	Festuca elatior.
Bidens tripartita.	Equisetum maximum.
B. cernua.	Polystichum angulare.

Scottish type three only—

Empetrum nigrum. Listera cordata.
Salix pentandra.

Of the Atlantic type one only—Hymenophyllum unilaterale.

The Highland type is represented by two species—Carex aquatilis, and Isoetes lacustris; the first named being an addition to the Irish flora.

The list of mosses is not to be considered as exhaustive. A number of common forms do not appear, and it may be taken for granted that some of these have been overlooked. Very minute forms have also escaped detection by reason of the insufficiency of time to make the search. Further, the mosses, which only come up during winter, remain unnoticed, on account of lack of opportunity at the proper season. Through these causes the list of mosses has been considerably reduced; nevertheless, though not to be taken as a complete census, yet it includes several of the less common species, and extends the range of others. Hypnum callichroum is an addition to the Irish flora, and the doubtful Andræa falcata is confirmed as an Irish plant. The variety, elegans, of Sphagnum acutifolium is also a new record.

I have again to return thanks for kind assistance in determining the critical species, which has enabled me to record these plants without any doubt as to the correctness of the names. Mr. G. A. Holt, of Manchester, made a microscopic examination of the greater part of the mosses and hepatics. Professor Babington determined the Rubi, while Messrs. H. and J. Groves, A. Bennett, F.L.S., J. Backhouse, and A. G. More, F.L.S., gave valuable help in their several specialities.

LIST OF SPECIES.

RANUNCULACEÆ.

Ranunculus hederaceus (Linn.)—Near Drumshambo chapel; rare.
R. flammula (Linn.)—Very common.
R. acris (Linn.)—Common.
Caltha palustris (Linn.)—Marshes; common.

NYMPHÆACEÆ.

Nymphæa alba (Linn.)—In Lough Allen, to the west of Drumshambo; very rare.
Nuphar lutea (Sm.)—At the extreme south of Lough Allen; rare.

CRUCIFERÆ.

Nasturtium officinale (R. Br.)—Common.
N. palustre (D. C.)—South end of the lough; rare.

Barbarea vulgaris (R. Br.)—Drumshambo, and borders of the lough; frequent.

Cardamine flexuosa (With.); C. sylvatica (Link.)—Not common; but occurs in the Leitrim, Roscommon, and Cavan portions of the district; ascends to 1600 feet on Slieveanierin.

C. hirsuta (Linn.)—Arigna old iron works, and limestone at Drumshambo.

C. pratensis (Linn.)—Wet pastures; common.

Sisymbrium officinale (Scop.)—Roadsides and waste ground; abundant at Drumshambo; rare elsewhere.

Brassica campestris (Linn.)—Waste ground; not common.

Sinapis arvensis (Linn.)—Fields; common.

Armoracia amphibia (R. Br.)—At the south end of the lough only.

VIOLACEÆ.

Viola palustris (Linn.)—Slievenakilla; ascending to 1500 feet.

V. sylvatica (Fries.); β. riviniana.—Common.

V. tricolor (Linn.)—Not common.

POLYGALACEÆ.

Polygala vulgaris (Linn.)—Common on the hills; rising to 1500 feet on Slieveanierin

CARYOPHYLLACEÆ.

Lychnis flos-cuculi (Linn.)—Extremely abundant in meadows and pastures; on Slieveanierin it reaches 1600 feet.

Sagina procumbens (Linn.)—Abundant.

S. nodosa (Linn.)—By Lough Scur; rare.

Stellaria media (Vill.)—Common.

S. holostea (Linn.)—Slievenakilla and Slieveanierin; frequent.

S. uliginosa (Murr.)—Very common.

Cerastium glomeratum (Thuil)—Roadside, Dowra, Co. Cavan; rare.

C. triviale (Link.)—Everywhere common.

Spergula arvensis (Linn.)—Fields and waste ground; frequent.

HYPERICACEÆ.

Hypericum androsæmum (Linn.)—Bank of stream, Dowra, Co. Cavan; very rare.

H. tetrapterum (Fries.)—Common in damp places.

H. pulchrum (Linn.)—Common.

GERANIACEÆ.

Geranium dissectum (Linn.)—Rare.

G. lucidum (Linn.)—On the limestone about Drumshambo; rare.

G. robertianum (Linn.)—Common.

OXALIDACEÆ.

Oxalis acetosella (Linn.)—Common in shady spots, especially on the hills.

LINACEÆ.

Linum catharticum (Linn.)—Frequent on the limestone at the south of the lough; rare, or absent elsewhere.

LEGUMINOSÆ.

Ulex europæus (Linn.)—About Drumshambo; not common on the hills.
Sarothamnus scoparius (Linn.)—Shores of the lough.
Medicago lupulina (Linn.)—Very rare; only on the limestone at the south of the lough.
Trifolium pratense (Linn.)—Common.
T. repens (Linn.)—Common.
T. dubium (Sibth.); T. minus (Sm.)—Common.
Lotus corniculatus (Linn.)—Very common.
Vicia cracca (Linn.)—Common about Drumshambo, and the borders of the lake.
V. sepium (Linn.)—Common.
Lathyrus pratensis (Linn.)—Common.

ROSACEÆ.

Prunus spinosa (Linn.); P. communis (Huds.)—Common.
Spiræa ulmaria (Linn.)—Common about the lough.
Alchemilla vulgaris (Linn.)—Common.
A. arvensis (Linn.)—Dowra, Co. Cavan; rare.
Potentilla anserina (Linn.)—Roadsides and waste ground; common.
P. tormentilla (Nesl.)—Common.
Comarum palustre (Linn.)—South end of the lough; not common.
Fragaria vesca (Linn.)—Ascends to 1600 feet on Slieveanierin; not common.
Rubus plicatus (W. & N.); var. nitida (W. & N.)—Under trees at the south-east shore of Lough Allen; not common.
[R. discolor (W. & N.)—I believe this occurs, but I failed to note it.]
R. leucostachys (Sm.)—Lough Allen and Lough Scur; not common.
R. leucostachys; R. vestitus.—"With whiter leaves than usual."—C. C. B.
R. hirtifolius (Müll.)—Common around the lough.
R. villicaulis (W. & N.); var. warreni (Blox. M. S.)—Lough Allen; very rare.
R. macrophyllus (Weih.)—Frequent around the lough.
R. macrophyllus, var. ε. glabratus (Bab.)—Not common.

R. koehleri γ pallidus (Weihe).—Not common. Of another form, which I place under R. koehleri; Professor Babington says "comes very near R. humifusus."

R. lejeunii (Weihe) (?).—"Armature most remarkable, R. lejeunii perhaps."—C. C. B.

Rosa canina (Linn.)—Common; the only rose seen.

Cratægus oxyacantha (Linn.)—Common; ascending to 1500 feet on Slieveanierin.

LYTHRACEÆ.

Lythrum salicaria (Linn.)—Common.

Peplis portula (Linn.)—South end of the lough, and by the road to Dowra; rare.

ONAGRACEÆ.

Epilobium montanum (Linn.)—Shady places; frequent.

E. obscurum (Schreb.)—Dowra, Co. Cavan; not common.

E. palustre (Linn.)—Wet places; frequent.

Circæa lutetiana (Linn.)—Bushy places by the lough; scarce.

HALORAGACEÆ.

Myriophyllum spicatum (Linn.)—Plentiful in the lough.

M. alterniflorum (D. C.)—Lough Allen; not common.

PORTULACEÆ.

Montia fontana (Linn.); var. rivularis (Gm.)—Wet places on the hills.

CRASSULACEÆ.

Sedum acre (Linn.)—Limestone rocks at Drumshambo; rare.

SAXIFRAGACEÆ.

Chrysosplenium oppositifolium (Linn.)—By rocky streams; rising to 1600 feet on Slieveanierin.

UMBELLIFERÆ.

Hydrocotyle vulgaris (Linn.)—Margins of the lough; not abundant.

Cicuta virosa (Linn.)—Frequent in drains at the south end of the lough.

Ægopodium podagraria (Linn.)—Drumkeerin, Co. Cavan; rare.

Carum (Bunium) flexuosum (With.)—By the lough, but not common.

Angelica sylvestris (Linn.)—Frequent, but not abundant.

Heracleum sphondylium (Linn.)—In great abundance.

Torilis anthriscus (Huds.)—Drumshambo; not common.

Anthriscus sylvestris (Linn.)—Common.

HEDERACEÆ.

Hedera helix (Linn.)—Rocks and walls; abundant.

CAPRIFOLIACEÆ.

Sambucus nigra (Linn.)—In great abundance.
Lonicera periclymenum (Linn.)—Very common.

RUBIACEÆ.

Galium aparine (Linn.)—Not common.
G. verum (Linn.)—On the limestone; not seen elsewhere.
G. saxatile (Linn.)—Throughout the district; perhaps the most abundant plant.
G. palustre (Linn.)—Common.

VALERIANACEÆ.

Valeriana officinalis (Linn.)—Common; ascends to 1600 feet on Slieveanierin.
V. officinalis; var. sambucifolia (Mik.)—This is a form with few broad leaflets, coarsely toothed all round. It occurs by Lough Allen, but does not seem to possess sufficient constancy.

DIPSACACEÆ.

Scabiosa succisa (Linn.)—By the lough, but not abundant.

COMPOSITÆ.

Petasites vulgaris (Desf.)—By the lough occasionally.
Tussilago farfara (Linn.)—Common.
Bellis perennis (Linn.)—Common.
Solidago virgaurea (Linn.)—Rocks near the summit of Slievenakilla; rare.
Pulicaria dysenterica (Linn.)—Roadside, Dowra to Drumshambo; rare.
Gnaphalium uliginosum (Linn.)—With the preceding; rare.
Achillea ptarmica (Linn.)—By the lough; not common.
Achillea millefolium (Linn.)—Frequent by the lough.
Matricaria inodora (Linn.)—Waste ground by houses; not at all plentiful.
Chrysanthemum leucanthemum (Linn.)—Very common.
Artemisia vulgaris (Linn.)—Roadside near Drumshambo; rare.
Senecio vulgaris (Linn.)—Common.
S. sylvaticus (Linn.)—Gravelly shore of the lough; rare.
S. jacobœa (Linn.)—Common.
S. aquaticus (Huds.)—Very common.
Bidens tripartita (Linn.)—Lough Allen and Lough Scur; rare.

B. cernua (Linn.)—Common in ditches at the south and west of the lough.

Arctium minus (Schk.)—A plant with larger heads than usual; but Professor Babington considers that I am right in placing it under A. minus.

A. intermedium (Lange).—Frequent by roadsides near Drumshambo; called by the natives "Crawthon."

Centaurea nigra (Linn.)—Common.

Carduus lanceolatus (Linn.)—Common.

C. palustris (Linn.)—Common.

C. arvensis (Linn.)—About Lough Allen; not common.

C. pratensis (Huds.)—Near the lough; rare.

Lapsana communis (Linn.)—By the lough; not common.

Hypochæris radicata (Linn.)—Very common.

Leontodon autumnalis (Linn.)—By the lough; frequent.

L. taraxicum (Linn.)—Common.

Sonchus oleraceus (Linn.)—Dowra and Drumkeerin; not common.

S. asper (Hoff.)—Walls of the disused iron works at Arigna, Co. Roscommon; rare.

Crepis virens (Linn.)—By Lough Allen, and ascends to 1600 feet on Slieveanierin.

Hieracium pilosella (Linn.)—Common.

H. vulgatum (Fries.)—Sandstone rocks, Slievenakilla; very rare. The absence of hawkweeds from the damp ledges of rock is remarkable.

AQUIFOLIACEÆ.

Ilex aquifolium (Linn.)—East side of the lough; rare.

GENTIANCEÆ.

Erythræa centaureum (Pers.)—Only found near Drumshambo, on the limestone.

Menyanthes trifoliata (Linn.)—South end of the lough; not common.

BORAGINACEÆ.

Myosotis palustris (With.)—Plentiful about the lough.

M. repens (Don.)—Rare by the lough; frequent on Slieveanierin and Slievenakilla; ascending to 1500 feet.

M. cæspitosa (Schultz).—Common in wet places.

M. arvensis (Lehm.)—Roadsides and fields about Dowra, Co. Cavan.

M. versicolor (Reich.)—Frequent.

SCROPHULARIACEÆ.

Digitalis purpurea (Linn.)—Very abundant; rises to 1500 feet on the mountains.

Scrophularia aquatica (Linn.)—In two or three spots on the west side of the lough; rare.

S. nodosa (Linn.)—Common.
Melampyrum pratense (Linn.); var. montanum (Johnst.)—Abundant on Slieveanierin, at 1600 to 1700 feet.
Pedicularis palustris (Linn.)—Abundant at the south end of the lough; rare elsewhere.
P. sylvatica (Linn.)—Common.
Rhinanthus crista-galli (Linn.)—Abundant.
Euphrasia officinalis (Linn.)—Common.
E. odontites (Linn.)—Roadside, Dowra to Drumshambo; not common.
Veronica beccabunga (Linn.)—Common.
V. chamædrys (Linn.)—Common.
V. officinalis (Linn.)—Common; ascends to 1500 feet.
V. serpyllifolia (Linn.)—On Slievenakilla and Slieveanierin, ascending to 1500 feet.

LABIATÆ.

Mentha aquatica (Linn.)—By the lough shores.
M. sativa (Linn.)—With the preceding.
Brunella vulgaris (Linn.)—Common.
Galeopsis tetrahit (Linn.)—Drumshambo; not seen elsewhere.
Stachys sylvatica (Linn.)—About Drumshambo; not common.
S. palustris (Linn.)—By the lough; not common.
Teucrium scorodonia (Linn.)—Ascends to 1500 feet on the mountains.
Ajuga reptans (Linn.)—Common; ascends to 1500 feet.

LENTIBULAREACEÆ.

Utricularia vulgaris (Linn.)—Sparingly in ditches by the south end of the lough.

PRIMULACEÆ.

Primula vulgaris (Linn.)—Common; occurs on the mountains at 1600 feet.
Lysimachia vulgaris (Linn.)—South end of the lough; rare.
L. nemorum (Linn.)—Very common; found at 1600 feet on the mountains.

PLANTAGINACEÆ.

Plantago lanceolata (Linn.)—Common; ascends to 1600 feet.
P. major (Linn.)—Roadsides, and on Slieveanierin.
Littorella lacustris (Linn.)—South end of the lough; not common.

CHENOPODIACEÆ.

Chenopodium album (Linn.)—Fields and waste ground.

POLYGONACEÆ.

Rumex obtusifolius (Linn.)—Common.
R. crispus (Linn.)—Dowra; not common.

R. acetosa (Linn.)—Common.
R. acetosella (Linn.)—Common.
Polygonum amphibium (Linn.)—Around the lough.
P. lapathifolium (Linn.)—Near the lough, occasionally.
P. persicaria (Linn.)—Common.
P. hydropiper (Linn.)—Common around the lough.
P. aviculare (Linn.)—Slieveanierin.
P. convolvulus (Linn.)—Drumshambo; not common.

Empetraceæ.

Empetrum nigrum (Linn.)—On the mountains.

Callitrichaceæ.

Callitriche verna (Linn.)—Common; rises to 1600 feet on Slievenakilla.

Urticaceæ.

Urtica dioica (Linn.)—Common.
U. urens (Linn.)—By Carrickaport Lake; not common.

Amentiferæ.

Salix pentandra (Linn.)—Near Drumkeerin; rare.
S. alba (Linn.)—By the lough side; not common.
S. purpurea (Linn.)—Drumshambo; rare.
S. cinerea (Linn.)—Common.
S. aurita (Linn.)—Common; occurs at 1600 feet on the mountains.
S. caprea (Linn.)—Around the lough.
Myrica gale (Linn.)—Heath on the west side of the lough
Corylus avellana (Linn.)—Not common.
Alnus glutinosa (Gaert.)—Around the lough.

Hydrocharidaceæ.

Anacharis alsinastrum (Bab.)—In Lough Allen.

Orchidaceæ.

Orchis maculata (Linn.)—In great abundance everywhere.
Habenaria viridis (R. Br.)—East of Drumshambo; two specimens only seen; but very luxuriant.
H. bifolia (R. Br.)—Drumshambo, Dowra, and Shannon Pot; frequent.
H. chlorantha (Bab.)—Common in damp pastures throughout the district.
Listera cordata (R. Br.)—Sparingly, at and above 1600 feet on Slieveanierin and Slievenakilla.

IRIDACEÆ.

Iris pseud-acorus (Linn.)—Plentiful about the lough; rare in the mountain districts.

ALISMACEÆ.

Alisma plantago (Linn.)—Ditches around the lough.
Triglochin palustre (Linn.)—Slievenakilla

MELANTHACEÆ.

Narthecium ossifragum (Huds.)—Bogs and heaths near Drumshambo; common.

JUNCACEÆ.

Juncus effusus (Linn.)—Common.
J. conglomeratus (Linn.)—Common.
J. glaucus (Sibth.)—By the south end of the lough.
J. articulatus (Linn.); J. acutiflorus (Ehr.)—Common.
J. lamprocarpus (Ehr.)—Common.
J. squarrosus (Linn.)—Abundant on the mountains.
J. bufonius (Linn.)—Very common.
Luzula maxima (D. C.); L. sylvatica (Bich.)—Frequent; rises to 1500 feet on Slievenakilla.
L. campestris (Willd.)—Heaths by the lough; frequent.
L. multiflora (Lej.); var. congesta.—Frequent on the mountains, and also by the lough.

TYPHACEÆ.

Typha latifolia (Linn.)—In Lough Scur, and in bog drains near Drumshambo; rare.
Sparganium ramosum (Huds.)—Lough Allen; not common.

LEMNACEÆ.

Lemna minor (Linn.)—Over the district, but not at all common.

POTAMOGETONACEÆ.

Potamogeton natans (Linn.)—Not abundant.
P. perfoliatus (Linn.)—Common in the lough.
P. crispus (Linn.)—Not common.
P. pusillus (Linn.)—In Lough Allen, but not abundant.

CYPERACEÆ.

Rhynchospora alba (Vahl.)—Bog by the lough; rare.
Eleocharis palustris (Linn.)—In the lough.
E. multicaulis (Sm.)—Lough Scur, near Drumshambo.
Scirpus lacustris (Linn.)—In the lough; scarce.

S. cæspitosus (Linn.)—Abundant on the mountains.
Eriophorum vaginatum (Linn.)—Common on the mountain bogs.
E. polystachion (Linn.)—Bogs; common.
Carex pulicaris (Linn.)—Common.
C. remota (Linn.)—Slievenakilla, and by Lough Allen; not common.
C. echinata (Murr.); C. stellulata (Good).—Very common.
C. leporina (Linn.); C. ovalis (Good.)—Common; ascends to 1500 feet on Slievenakilla.
C. stricta (Good.)—By the lough; a small, slender form.
C. aquatilis (Wahl.)—In a wet thicket at the margin of Lough Allen, on the Roscommon side of the old Shannon-bridge at Ballantra, a few dense tufts, with stems sometimes 3 feet high. Not previously known as occurring in Ireland.
C. goodenovii (Gay); C. vulgaris (Fr.)—Common.
C. pallescens (Linn.)—Wet pastures at the Shannon Pot, county Cavan; rare.
C. panicea (Linn.)—By the lough.
C. pilulifera (Linn.)—Heaths by Lough Allen, and also on Slieveanierin.
C. glauca (Murr.)—Very common.
C. flava (Linn.)—Common.
C. binervis (Sm.)—On the mountains; ascending to 1600 feet.
C. hirta (Linn.)—Frequent.
C. rostrata (Stokes); C. ampullacea (Good.)—Common.
C. vesicaria (Linn.)—Frequent at the south end of the lough.

GRAMINEÆ.

Phalaris arundinacea (Linn.)—By the lough; also on Slievenakilla; not common.
Anthoxanthum odoratum (Linn.)—Common.
Phleum pratense (Linn.)—Frequent.
Alopecurus geniculatus (Linn.)—By the lough; not common.
Nardus stricta (Linn.)—Common on the mountains.
Agrostis vulgaris (With.)—Common.
A. alba (Linn.)—Not common.
Holcus mollis (Linn.)—Boggy pastures; frequent.
Aira cæspitosa (Linn.)—Common; ascends to 1500 feet on Slieveanierin.
A. flexuosa (Linn.)—Heaths by the lough; also on Slieveanierin, at 1500 feet.
A. caryophyllea (Linn.)—Frequent.
A. præcox (Linn.)—Not common.
Avena flavescens (Linn.)—South end of the lough; rare.
Arrhenatherum elatius (M. & K.); A. avenaceum (Beauv.)—Common, up to 1600 feet.
Trioda decumbens (Beauv.)—On the limestone at the south end of the lough; also on Slieveanierin, at 1600 feet.

Molinia cærulea (Moench.)—Very luxuriant, by the lough.
Poa annua (Linn.)—Roadsides; common.
P. trivialis (Linn.)—Pastures.
P. pratensis (Linn.)—Frequent.
Glyceria fluitans (R. Br.)—Ditches; common.
Catabrosa aquatica (Beauv.)—West of Drumshambo; rare.
Cynosurus cristatus (Linn.)—Common.
Dactylis glomerata (Linn.)—Common.
Festuca rubra (Linn.)—Common.
F. elatior (Linn.)—By the lough.
F. pratensis (Huds.)—In wet places by the lough.
Bromus racemosus (Timm.)—Drumshambo and Arigna; rare.
Lolium perenne (Linn.)—Common.

EQUISETACEÆ.

Equisetum arvense (Linn.)—Common.
E. maximum (Lamk.)—Not common.
E. sylvaticum (Linn.)—By the lough; also on Slieveanierin, at 1600 feet; rare.
E. limosum (Linn.)—Common.
E. palustre (Linn.)— Common.

FILICES.

Polypodium vulgare (Linn.)—Frequent, but not abundant.
Lastrea filix-mas (Presl.)—Common; ascends to 1600 feet.
L. dilatata (Desv.)—Common; ascends to 1700 feet.
Polystichum angulare (Willd.)—Common.
Cystopteris fragilis (Bernh.)—Walls of old iron works at Arigna; very rare.
Athyrium filix-fœmina (Bernh.)—Common; very fine, at 1600 feet.
Asplenium adiantum-nigrum (Linn.)—Walls of old works at Arigna; also at 1600 feet on Slieveanierin; rare.
A. trichomanes (Linn.)—Walls of Arigna, and by the Stony River, Slieveanierin.
A. ruta-muraria (Linn.)—Abundant on the old Shannon-bridge at Ballantra, and near the Drumkeeran coal-pits; rare.
Scolopendrium vulgare (Sm.)—Common.
Blechnum boreale (Sw.)—Common; ascends to 1600 feet.
Pteris aquilina (Linn).—Common.
Hymenophyllum unilaterale (Willd.)—Sandstone cliffs, Slievenakilla, at 1500 feet; Slieveanierin, at 1800 feet; counties Cavan and Leitrim; very rare.

LYCOPODIACEÆ.

Isoetes lacustris (Linn.)—South end of the lough; very rare.
Lycopodium selago (Linn.)—Frequent on the mountains.

Characeæ.

Chara contraria (Kuetz.)—In the lough; apparently rare.
Nitella flexilis (Ag.)—In Lough Allen; with the preceding.
N. opaca (Ag.)—Abundant in the lough.

Musci.

The classification is the same as that of Moore's "Synopsis of the Mosses of Ireland."

Dicraneæ.

Dicranella squarrosa (Schrad.)—Damp rocks on Slieveanierin; rare and barren.
Ceratodon purpureus (Linn.)—Common.
Dicranum pellucidum (Hedw.)—Slieveanierin; not common.
D. scottianum (Turner).—Slieveanierin; very fine, but without fruit.
Distichum capillaceum (Hedw.)—Abundant on the limestone at Drumshambo.

Grimmieæ.

Grimmia pulvinata (Dill.)—Lough Allen; frequent.
G. apocarpa (Turner), var. rivulare.—Wet places, Slieveanierin, and Lough Allen; frequent.
Racomitrium lanuginosum (Hedw.)—On rocks, Slieveanierin.
R. aciculare (Linn.)—Slieveanierin, and Lough Allen; abundant.
R. fasciculare (Dill.)—Slieveanierin and Lough Allen.

Leucobryeæ.

Leucobryum glaucum (Hedw.)—Slievenakilla.

Trichostomaceæ.

Didymodon rubellus (B. & S.)—Common at Drumshambo,
Trichostomum tophaceum (Brid.)—By the lough.
Ditrichum homomallum (Hedw.)—Drumshambo; not common.
D. flexicaule (Schw.)—Abundant on the limestone at Drumshambo; barren.
Tortula aloides (Koch)—Walls at Drumshambo.
T. revoluta (Schw.)—Common about the lough.
T. vahliana (Schultz)—Lough Allen; rare.
T. muralis (Linn.)—Common.
T. muralis, var. rupestris.—Limestone at Drumshambo.
T. unguiculata (Dill.)—Common around the lough.
T. fallax (Hedw.)—With the preceding, and still more abundant.
T. cylindrica (Tayl.)—By Lough Allen.
T. reflexa (Brid.)—Limestone rocks near Drumshambo; very rare.
T. subulata (Linn.)—Frequent.
T. tortuosa (Linn.)—On an old wall at Drumshambo.

T. rigidula (Hedw.)—Plentiful about the lough.
Encalypta streptocarpa (Hedw.)—Abundant on an old wall at Drumshambo.
Cinclidotus fontinaloides (Hedw.)—Frequent around Lough Allen.

ORTHOTRICHEÆ.

Orthotrichum affine (Schrad.)—On trees; common about Drumshambo.
O. phyllanthum (Brid.)—Abundant on trunks of trees.

BARTRAMIEÆ.

Bartramia fontana (Linn.)—Very common.
B. arcuata (Dicks.)—Common about the lough.

BRYEÆ.

Bryum nutans (Hedw.)—Damp walls at Arigna; rare.
B. cernuum (Hedw.)—Walls at Drumshambo; rare.
B. capillare (Linn.)—Common.
B. murale (Wills.)—Old walls at Drumshambo.
Mnium punctatum (Hedw.)—Damp rocks, Slieveanierin.
M. hornum (Linn.)—Abundant on Slieveanierin.

NECKEREÆ.

Fontinalis antipyretica (Linn.)—Abundant in the Upper Shannon.
Neckera crispa (Dill.)—About Lough Allen.

HYPNEÆ.

Climacium dendroides (Dill.)—By the lough; barren.
Leskea polycarpa (Hedw.)—Plentiful, and in fine fruit in a wet thicket on the borders of the lake, close to the old Shannonbridge; still more abundant at Derryhallagh Lake, close to Drumshambo.
Hypnum denticulatum (Dill.)—Lough Allen.
H. glareosum (B. & S.)—Lough Allen; rare and barren.
H. rivulare (B. & S.)—Mountain streams; rare.
H. plumosum (Sw.)—Frequent.
H. prælongum (Dill.)—About the lough.
H. palustre (Linn.)—Lough Allen.
H. cuspidatum (Dill.)—Common about the lough.
H. purum (Linn.)—Plentiful about the lough.
H. kneiffii (Schimp.)—In a well close to Drumshambo limestone quarries, growing in long floating tufts; barren.
H. molluscum (Hedw.)—Abundant on the limestone rocks at the south end of the lake.
H. cupressiforme (Dill.), var. lacunosum.—By Lough Allen; rare.
H. cupressiforme, var. compressum.—On the mountains, and about the lough; frequent.

H. splendens (Hedw.)—Common, but without fruit.
H. triquetrum (Dill.)—Frequent around the lough.
H. loreum (Dill.)—Abundant on Slievenakilla.
H. squarrosum (Dill.)—Common.
H. callichroum (Brid.)—Lough Allen; rare and barren. New to Irish flora.

SKITOPHYLLEÆ.

Fissidens adiantoides (Hedw.)—Limestone rocks at Drumshambo.

POLYTRICHEÆ.

Pogonatum alpinum (Linn.)—Slieveanierin.

SPHAGNEÆ.

Sphagnum cymbifolium (Brid.)—Slieveanierin.
S. cuspidatum (Ehr.)—Slieveanierin.
S. acutifolium (Ehr.)—Lough Allen.
S. acutifolium, var. elegans.—Lough Allen.

ANDREACEÆ.

Andræa falcata (Schimp.)—Slieveanierin; rare. Not previously published as an Irish plant. The late Mr. G. E. Hunt had collected specimens in this country, so named, but Dr. Moore hesitated to include it in his list; Mr. Hunt was therefore the first to detect this plant in Ireland.

HEPATICÆ.

Porella platyphylla (Linn.)—Lough Allen; frequent.
Lepidozia cupressina (Sw.)—Lough Allen.
Bazzania tricrenata (Wahl.); B. deflexa (Mart.)—Plentiful on Slieveanierin.
Scapania undulata (Linn.)—Abundant on Slieveanierin.
S. æquiloba (Schwg.)—Slieveanierin; rare. The only other Irish locality for this species is that mentioned by Dr. Moore, "near the head of Gleniff," also in Leitrim.
Diplophyllum albicans (Linn.)—Common.
Blasia pusilla (Linn.)—Southern end of Lough Allen.
Metzgeria furcata (Linn); var. æruginosa (Hook.)—Common on trees.

XXI.—REPORT ON THE FLORA OF SOUTH-WEST DONEGAL. By HENRY CHICHESTER HART, B.A.

[Read, February 23, 1885.]

THE following Paper combines the results of my explorations in southern Donegal in the years 1883 and 1884. In the latter year I had the assistance of a grant from the Academy, and as the results of the previous season are still unpublished, and belong to the same district, I take the opportunity of combining the two into one report.

The districts explored extended over the whole south of the county; several of the localities visited require, however, further examination and earlier visits. My head-quarters lay chiefly at Carrick, Killybegs, and Donegal; but I also paid visits of two or three days' duration each to Ballyshannon, Bundoran, Pettigo, and Stranorlar.

To enumerate my various expeditions would be tedious and unprofitable, but I may be pardoned for giving a rapid geographical sketch of the ground traversed—chiefly in the baronies of Banagh and Tirhugh. Thus I examined the coast line from Tormore to the county boundary south of Bundoran, leaving no creek or shore unsearched or promontory unencompassed. I spent several days on Slieve League, and climbed the range at about its middle height along the seaward face, as well as exploring minutely the inner and more profitable cliffs. The shores of Lough Eske received a careful search, as well as numerous other lakes in the neighbourhood of Carrick, Pettigo, and Ballyshannon: the banks of the rivers Finn, Reelan, Loughhead, Eany, Glen, and Erne were botanized, as well as some other smaller streams. In a previous year I had examined the Bluestack range of mountains[1] which lie in the district under consideration, but otherwise the botany of this part of the county was almost unknown to me, and, except superficially or at a few isolated points, undealt with at all.

Numerous interesting discoveries rewarded my labours. As these sometimes occurred in whole batches, I will give a short summary of the rarer plants in the most productive stations. The most prominent of these is Slieve League: with it I propose to deal in full.

It will be well, however, first to draw attention to the geological structure of this part of Donegal, for on it the botanical interest mainly depends. On leaving Slieve League, a short distance in an easterly direction along the coast brings us from the usual shales, schists, and quartzite of the older formations to a band of carboniferous limestone, which extends almost uninterruptedly along the outer headlands and shores of Donegal Bay to Bundoran. It is occasionally replaced by Silurian rocks and sometimes by an almost equally fertile limestone

[1] See *Journal of Botany*, 1882.

of an older date. This belt reaches inland several miles in some places, as at Brown Hall, Lough Esk, and along the Erne to Belleek; and to it is due the presence of several lime-loving species which do not occur elsewhere in the county. Moreover, the warmer and more productive soil to which it gives rise supports some species which would not otherwise occur so far north; acting, as the Derry trap-rocks do, in enabling lowland species there to reach an unwonted altitude. Another noticeable feature in the limestone flora is the variety of its species and the small quantity of this kind of derivative soil which enables them to exist. The absence of the gregarious turf-loving dominant sorts of heather is also remarkable, and a chief cause of the varied flora. The line of junction of limestone hills with those of other formation is recognizable at a considerable distance (as in the neigbourhood of Ballyshannon) by this prevalence or absence of heather.

River Erne.

Between Ballyshannon and Belleek, along the banks of the river Erne, a noble body of water rushing over a series of limestone cascades about five miles long, I gathered the following plants:—*Cornus sanguinea*, sparingly on the right bank; *Nasturtium amphibium*, *Lysimachia vulgaris*, and *Rumex hydrolapathum*, more plentiful—the first two on both banks. In "Cliff," the beautifully wooded residence of the late Mr. T. Connolly, by the water's edge in thickets occurred *Geranium lucidum*, *Alliaria officinalis*, *Quercus sessiliflora*, and *Triticum caninum*, the last mentioned occurring also on the opposite or left bank. On the left bank of the river, about half way and nearer to Ballyshannon, *Carex vesicaria* is plentiful, while *Scutellaria galericulata*, *Euonymus europæus*, *Cystopteris fragilis*, and other local species, occur in several places. *Elodea canadensis* has found its way into this water, and here also is the only Donegal locality for the rare fern *Lastrea thelypteris*, where it was discovered by my friend A. G. More.

Lough Eske.

This lake is about ten miles round, and most beautifully situated at the southern base of the rugged, desolate cliffs of the Bluestack mountains. Its western shores are girt with wood, which are chiefly natural, as at Ardnamona, and the whole basin with its limestone floor is admirably sheltered by surrounding mountains from the violent storms, apparently on the increase, which visit this country. Of rain, however, this valley gets more than its share. The river from Lough Eske to the sea at Donegal is about the same length as that from Lough Erne at Belleek. Along its banks I gathered *Carex pendula*, sparingly in one place on the right bank, not far above Donegal, *Salix pentandra*, *Utricularia intermedia*, *Viburnum opulus*, *Cladium mariscus*, *Parnassia palustris*, *Festuca sylvatica*, *Carex hornschuchiana*, *Equisetum maximum*, *E. sylvaticum*, *E. hyemale*, and *E. variegatum*.

Several other interesting northern and western, but more abundant, species were noticed along this river—a rapid stream, with many pretty reaches between high limestone banks. On the immediate margin of the lake, along the western side, *Milium effusum*, *Carex filiformis*, and *Hieracium umbellatum* were gathered, the latter, with *Equisetum variegatum*, being abundant in several places. At the north-eastern end I met with *Carum verticillatum* in some quantity—an important discovery. *Hieracium anglicum* was found at the south-east end, while *H. umbellatum* is common. *Thrincia hirta*, *Eleocharis pauciflora*, *Sesleria cærulea*, and *Sagina subulata*, occurred here also. In the Ardnamona woods, after a careful and deliberate search, I succeeded in discovering the Killarney fern, *Trichomanes radicans*, a stunted but healthy form. I should hardly have sought it so carefully had it not been already found in the Poisoned Glen, and I felt sure that if it occurred anywhere in the county, Lough Eske would have a claim to put in. In these woods I met with the rare *Cephalanthera ensifolia*, which was originally discovered here by Mrs. Brooke of Lough Eske. I found here in one open glade great profusion of *Epipactis palustris*, very rare in the north of Ireland. *E. latifolia* is abundant, sometimes 3 feet high, and varying to *E. media*, Fries.; *Prunus padus*, *Polypodium phegopteris*, *Hymenophyllum tunbridgense*, *Lastrea spinulosa*, and, on the outskirts, *Carex pallescens*, all occur here. Below Lough Eske Castle Miss Young informed me she gathered *Elatine hexandra*, and near this is the locality whence that ill-fated botanist, Mr. Corry, recorded *Melampyrum sylvaticum*. I could not re-discover it. A good many of the foregoing species have not previously been found in Donegal.

St. John's Point, Donegal Bay.

St. John's Point is the extremity of a low, narrow limestone promontory, stretching out in a south-westerly direction about six miles into Donegal Bay from its northern shore. It is seldom half a-mile in width, and its greatest elevation is 150 feet. The pasturage of this spit of land is superb, and cattle attain a condition here which I am told they cannot maintain when transferred to any neighbouring grazing. A main ingredient in the feed is the "blue grass," *Sesleria cærulea*, which is confined to the limestone, and appears to be highly nutritive. The limestone pastures about Ballyshannon and Brown Hall, famous for their beef, abound with this grass also. On the sides of this promontory *Trifolium medium* and *Parnassia palustris* are very common. At the extremity is an almost isolated patch of rocky land from two to three miles in circumference on which stands the lighthouse. The limestone here is intersected with fissures and cracks, and forms long low terraces in the same manner as that of the Aran Islands in Galway Bay, and my hopes of finding a similar flora were not altogether disappointed. The following species, several of which are new to the county, were tolerably plentiful:—*Euonymus europæus*,

Galium boreale, *Hieracium iricum*, *Lychnis diurna*, *Pulicaria dysenterica*, *Geranium sanguineum*, *Eupatorium cannabinum*, *Rubus saxatilis*, and *Agrimonia eupatorium*; while *Carlina vulgaris*, *Arabis hirsuta*, and *Geranium lucidum* were found more sparingly. *Crithmum maritimum*, *Eleocharis pauciflora*, and *Asplenium ruta-muraria*, also occur; and in the swampy ground at the inner edge of the point *Carex riparia* was found in one wet place near a cottage below Rabley Hill. This point has not been previously noticed by botanists.

Although not occurring on this point, I may mention here the most interesting species which occur along the northern shore of Donegal Bay. At the extreme western point (Rathlin O'Beirne's Island) I found *Statice occidentalis;* and travelling east and south at various points, given subsequently, occur *Adiantum capillus-veneris*, *Sagina subulata*, *Saxifraga oppositifolia*, *Sedum rhodiola*, *Ophioglossum lusitanicum*, *Statice bahusiensis*, *Blysmus rufus*, *Elymus arenarius*, and *Vicia sylvatica*.

Slieve League.

This mountain, long celebrated amongst lovers of cliff scenery, has not hitherto been searched by anyone accustomed to seeking for alpine plants. The only record I find in the *Cybele Hibernica* is that of "*Salix herbacea*, 1800 feet to the top, Slieve League," which is taken from Dickie's *Flora of Ulster*. In More's *Supplement* three further records appear; two from Mr. Dunlop, *Saxifraga aizoides* and *Asplenium viride*, from the north side, and *Adiantum capillus-veneris* from the cliffs of Slieve League, where it was first found by the Rev. Lucius O'Brien.

Slieve League is 1972 feet high at its highest point. The summit is west of the centre of a ridge of maritime cliffs, extending about three miles from north-west to south-east, towering above the sea on the south face, and sinking swiftly away in heather and bog on the inland side. The sea cliffs are by no means sheer throughout. I have climbed them in all directions, from end to end, and from the sea to the summit; but in many places there are walls of cliff of great height rising straight up from the ocean, and of the most gorgeous colouring. There is a track to the sea at one place between the Eagle's Nest and the One Man's Pass. While scrambling along the sea face I came on this track amongst the steep heather, bracken, and bear-berry, and a bare-foot print induced me to follow it to the water's edge. Considerably above the sea the track had disappeared, but I could still notice footholds on the almost vertical rock, and finally appeared an old man and a little boy emerging from the ocean brink. They were loaded with samphire, which they eat as they rested in their climb, and were vastly surprised at my appearance—the only stranger they had ever seen there, and they besought of me to go no further with my boots on! I have never before found the peasants using raw samphire as food. Boiled with milk it is supposed to cure a cough. This track is called Thone-na-culliagh.

Slieve League, east of the summit, descends on the inland side in a series of north-facing declivities, intersected by several steep gullies, to the coom, containing Lough Agh. The wet schistose cliffs of this part of the mountain, which is elsewhere mainly quartzite, have disintegrated to a rich yellow, heavy clay, lying on the ledges and hollows, and by the sides of the various gullies. With the keenest satisfaction I discovered that this ground still harboured a considerable remnant of our oldest flora, and that those alpine species occurring do so as a rule profusely, in some places monopolizing the soil. The following is a list of these alpine species occurring on Slieve League. Some of these, however, descend to sea level, even so far south as Kerry. These have found our moist climate so satisfying, that they have passed out of their limits, and cannot be called alpine in Ireland :—

Thalictrum alpinum.
Dryas octopetala.
Sedum rhodiola.
Saxifraga stellaris.
S. aizoides.
S. oppositifolia.
Saussurea alpina.
Hieracium[2] anglicum, Fr.
H. iricum, Fr.
Arbutus uva ursi.
Vaccinium vitis-idæa.
Polygonum viviparum.
Oxyria reniformis.
Salix herbacea.
Juniperus nana.
Carex rigida.
Polystichum lonchitis.
Asplenium viride.
Lycopodium alpinum.
Selaginella selaginoides.
Isoetes lacustris.

Of these, Dryas and hollyfern are additions to the county list. Both have previously been erroneously recorded from other places in Donegal.

Two others, *Sesleria cærulea* and *Galium boreale*, occur at no great distance from Slieve League, in this barony of Banagh, so that the alpine total for this neighbourhood reaches twenty-three. The rest of the county only furnishes, besides Hieracia, three more alpines, *Draba incana*, *Silene acaulis*, and *Carex aquatilis*,[3] none of which occur on the higher mountains. Slieve League can, I think, hold its own against any Irish mountain for its number of alpine species. Considering its small extent of suitable ground, this is satisfactory. The total alpines of the county is also, I believe, as large, or larger, than any other.[4]

Many of these species reach an unusually low level on Slieve League, and as I was careful to observe the altitudes with my

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[2] These Hieracia have been kindly determined for me by Mr. J. Backhouse.

[3] C. aquatilis of Donegal is the lowland form, C. watsoni, and should probably be classed amongst the "northern," not "alpine" group of Watson.

[4] Pending Mr. Barrington's Report on Ben Bulben, I cannot speak with certainty.

aneroid, both this year and last, I will append a list of elevations. Where no observation occurs after the name of a species, it may be concluded that the plant is frequent, and descends to low levels from the height quoted; otherwise I have endeavoured to observe both upper and lower limits.

Slieve League.

Summit, 1970 to 1950.

Calluna vulgaris.
Erica cinerea.
Empetrum nigrum. Descending to sea-level.
Salix herbacea. Descending to 1500 feet on the north side.
Juncus squarrosus.
Luzula sylvatica.
Carex rigida. Descending to 1400 feet, north-east face.
C. binervis.

1900 feet.

Arctostaphylos uva-ursi. Looking south from just below the summit to sea-level.
Vaccinum vitis-idæa. North-end of summit; descending to 1400 feet.

1850 to 1800 feet.

Saxifraga oppositifolia. Descending to 800 feet on sea cliffs looking north-west, and to 400 feet by the stream out of Croleavy Lough, and the same height on sea-face of Leahan.
Vaccinum myrtillus.
Scirpus cœspitosa.
Polystichum lonchitis. Descending to 1470 feet on the northern side.
Asplenium dilatatum.

1800 to 1750 feet.

Potentilla tormentilla.
Galium saxatile.
Scabiosa succisa.
Antennaria dioica. Descends to sea-level.
Euphrasia officinalis.
Thymus serpyllum.
Carex pilulifera.
Festuca duriuscula.
Lastrea filix-mas.
Lycopodium alpinum. North shoulder of summit; not found lower down.
Selaginella spinulosa. Descends to sea-level.

1650 feet above Lake Agh; and at 1560 feet elsewhere.

Pyrus aucuparia.
Pinguicula vulgaris.
Plantago maritima. And at 1400 feet.

1600 feet above Lake Agh.

Cerastium triviale.
Saussurea alpina. To 1330 feet.
Juncus uliginosus.
Asplenium viride.

1560 feet; north end of mountain.

Hieracium vulgatum. And lower to 1400 feet above sea-level above Lough Agh.
Digitalis purpurea.
Veronica officinalis.

1550 feet; cliff looking north; near Lake Agh.

Thalictrum alpinum. Descending to 1310 feet above sea-level.
Saxifraga aizoides. To 1140 feet.
Oxyria reniformis. To 1050 feet.
Asplenium viride. To 1200 feet.
Lycopodium selago.

1500 feet.

Cardamine pratensis.
Viola palustris.
V.? sylvatica.
Chrysosplenium oppositifolium.
Hieracium anglicum. To 1400 feet.
Koeleria cristata. And again at 1400 feet.
Cystopteris fragilis. To 1040 feet.

1470 feet.

Hieracium (decipiens ?).
Listera ovata.
Carex binervis.

1450 feet.

Oxalis acetosella.
Sedum rhodiola. To sea-level.
Angelica sylvestris.
Jasione montana.

Crepis paludosa.
Aira flexuosa.
Agrostis vulgaris.
Molinia cærulea.
Hymenophyllum unilaterale.

1400 feet; north and north-east end.

Ranunculus acris.
Saxifraga stellaris. To 1000 feet, and probably lower.
Solidago virgaurea.
Campanula rotundifolia.
Primula vulgaris.
Asplenium dilatatum.

1350 feet; west side.

Bellis perennis.
Cynosurus cristatus.
Carex pulicaris.

1310 feet; looking north; near Lake Agh.

Dryas octopetala.
Polygonum viviparum.

These two occur together sparingly in only one place, where I have noticed them in 1883 and 1884. They are accompanied by holly fern, and other alpines. Dryas is very scarce here.

1300 feet.

Montia fontana.
Taraxacum dens leonis.
Leontodon autumnalis.
Athyrium filix-fœmina.
Asplenium trichomanes.

1100 feet.

Carex flava.

1050 feet.

Hypericum pulchrum.
Rubus saxatilis.
Lonicera periclymenum.

1000 feet; west side.

Erica tetralix.

925 feet above Lake Agh, to its east.

Ranunculus flammula.
Polygala vulgaris.
Stellaria uliginosa.
Epilobium palustre.
Prunella vulgaris.
Lysimachia nemorum.
Eleocharis multicaule.

850 feet; Lake Agh.

Sedum anglicum.
Lobelia dortmanna.
Littorella lacustris.
Myosotis repens.
Potamogeton natans.
Sparganium minimum.
Isöetes lacustris.

850 to 750; sea face of mountain.

Rosa pimpinellifolia.
R. canina.
R. tomentosa.
Listera cordata. And at 550 feet; north-east side; 400 feet, north end.
Salix cinerea.
S. aurita.
S. repens.

820 feet; looking east.

Pteris aquilina.

800 feet; looking east.

Carduus palustris.
Blechnum boreale.
Lastrea æmula.

750 feet; looking east.

Trifolium medium.
Alchemilla arvensis.
Carex dioica.

700 feet; sea-cliffs between Leahan and Slieve League.

Gentiana campestris.
Anagallis tenella.
Polystichum aculeatum.

650 feet; sea-cliffs between Leahan and Slieve League.

Geranium robertianum.
Gnaphalium sylvaticum.
Filago germanica.
Teucrium scorodonia.
Plantago coronopus.
Asplenium adiantum-nigrum.

600 feet; sea-cliffs between Leahan and Slieve League.

Ranunculus bulbosus.
Cochlearia officinalis.
Anthyllis vulneraria.
Silene maritima.
Epilobium montanum.

Same height; bog at north-west of mountain.

Drosera rotundifolia.
D. intermedia.
D. anglica.
Pinguicula vulgaris.
P. lusitanica.
Rhynchospora alba.

400 feet; northern slopes.

Carex dioica.

350 feet; Carrigan Head.

Radiola millegrana.

Sagina subulata. Very abundant on sea cliffs at about this height and lower.

Juniperus nana. Probably occurs higher also, but I have no note of it.

Ophioglossum lusitanicum. Same form as that of Horn Head, Brandon Head, and Sybil Head. Called by Syme *O. polyphyllum*, but is not "polyphyllous." At lower levels round the base occur commoner species; on the sea cliffs *Crithmum maritimum*, *Ilex aquifolium*, *Adiantum capillus veneris;* and inland, *Carex limosa*, *C. paniculata*, *Mimulus luteus*, *Rubus idæus*, *Hypericum elodes*, *H. androsæmum*, and several gregarious bog plants found everywhere at low levels.

In the foregoing sketches there are many additions to the flora of the county Donegal. Others which do not there appear will be given in the list at the end of this report. Amongst these, two, *Hieracium argenteum*, Fries, *Carex bœninghauseniana*, Weihe, are additions to the flora of Ireland, and *Carex aquatilis*, W., has only just been added to its flora by Mr. Stewart. I will now enumerate the rarer species met with, with their habitats. A few, now first recorded, which belong to other parts of the country, may be included. Commoner species will not, unless presenting some point of peculiar interest, be alluded to here.

Thalictrum alpinum, Linn. Slieve League, above Lough Agh, from 1550 to 1310 feet above sea level. Found also on the Bluestack mountains, and at the Poisoned Glen in Donegal.

Ranunculus heterophyllus, Bab. Bundrowes bridge, near Bundoran, in ditches leading to the river.

R. baudotii, Godron. By a little stream at Kildoney point, N.W. from Ballyshannon.

R. pseudo-fluitans, Syme. River Eske above Donegal; river Erne; Bundrowe's river near Bundoran.

R. sceleratus, Linn. Shore S.W. from Donegal.

[*R. lingua*, Linn. Recorded by Mackay from the shores of Lough Eske, apparently an error. Not yet found in Donegal.]

Trollius europæus, Linn. In several places along the river Finn, on both banks between Drumbo and Cloghaun bridge, especially on the left bank immediately below this bridge, at the water's edge. This is the second Irish locality, the other occurring also in Donegal.

Nymphæa alba, Linn. Far commoner than *Nuphar lutea*, Linn., which, however, occurs in lakes near Pettigo, Carrick, &c. &c.

**Papaver dubium*, Linn. Innisfad, on the coast S.W. from Donegal.

**P. somniferum*, Linn. Fields about Bundoran, apparently established.

**Fumaria capreolata*, Linn. And **F. officinalis*, Linn. Both frequent, especially in turnip fields, with which crop they appear to be introduced.

Barbarea vulgaris, R. Br. By river Erne, and at Ballyweal by the shore, near Donegal. A local plant in Donegal.

Arabis hirsuta, Linn. Right bank of the Erne near Ballyshannon; St. John's Point.

{*A. thaliana*, Sm. Walls at Pennyburn near Derry, W. E. Hart; from whom I have had specimens.}

Cardamine sylvatica, Link. Woods at Lough Eske Castle.

**Sisymbrium officinale*, Scop. Ballyshannon; Inver; &c. Not common, and probably not native.

Alliaria officinalis, Aud. Thickets by the Erne at Cliff, near Belleek, on the right bank.

**Sinapis nigra*, Linn. By the shore, on the edge of cultivated fields between Killymard Rectory and the Hall, Mount Charles. Very rare, and probably introduced.

**Sinapis alba*, Linn. Potato fields by the Finn, near Glenmore. Thinly introduced.

Draba verna, Linn. Sandy downs between Bundoran and Ballyshannon; Miss Young.

Cochlearia danica, Linn. Shingly shore at the point of Ballyboyle, near Donegal.

Armoracia amphibia, Koch. In the Erne above Ballyshannon in several places. Not hitherto recorded, nor likely to occur elsewhere in Donegal, although "11" is inserted in the list of districts after this plant in the *Cybele Hibernica.*

**A. rusticana*, Rupp. Established near Bundoran.

**Viola odorata*, Linn. A considerable growth of, I believe, this species occurs near the mouth of the river Letter, into Lough Erne, near Pettigo. My visit was too late to determine the species with certainty.

Viola curtisii, Forst. Sandhills at Bell's Isle, S.W. from Donegal; at Fintragh Bay, between Ballyshannon and Bundoran.

V. tricolor, Linn. Fields by the Finn, between Stranorlar and Killygordon.

Drosera intermedia, Hayne. By Laree Lake near Ballyshannon; wet bog north of Lough Unshagh, near Slieve League.

D. anglica, Huds. East side of Lough Eske; marsh below Breezy Hill, west of Ballyshannon; with the last near Lough Unshagh.

Parnassia palustris, Linn. Common on the limestone from Bundoran to St. John's Point.

Elatine hexandra, D. C. Lough Eske, south-west margin, a little north of the Castle; Miss Young.

Silene inflata, Sm. Right bank of the Erne, about two miles above Ballyshannon; fields near Ballyshannon and Bundoran, in several places.

Lychnis vespertina, Sibth. Fintragh Bay; near the road between Ballyshannon and Bundoran. In both places both white and pink.

L. diurna, Sibth. Foster's Island, near Donegal; at Cliff, near Belleek; St. John's Point; Doorin Point, near the old coastguard watch-house.

**L. githago*, Linn. Fields by the roadside between Dunkineely and Killybegs. Occasionally abundantly introduced with vetches, and sometimes amongst corn.

Sagina subulata, Wimm. Shores of Lough Eske at the south-east corner; Glen Head; Mucross Point; abundant on the sea cliffs about Carrigan Head, Leahan and Slieve League, from about 300 to 600 feet above sea-level.

S. nodosa, E. Meyer. Shores of Lough Eske, in several places; Sand-hills near Ballyshannon; Glen Bay.

Honkeneya peploides, Ehrh. Trabane strand, near Malinbeg; Tawny Bay.

Arenaria serpyllifolia, Linn. St. John's Point; Bell's Isle; between Ballyshannon and Bundoran.

Stellaria graminea, Linn. By the Eske, Finn, Erne, and Lough-head rivers; Fintragh Bay.

Cerastium tetrandrum, Curt. Glen Bay; sand-hills at head of Inver Bay.

C. semidecandrum, Linn. Sand-hills at head of Inver Bay.

**Althæa officinalis*, Linn. Kiln Bay, near Dunkineely, where it is established, but evidently an escape; thoroughly established at the margin of sea and cultivated land at the north-east corner of Glen Bay. This plant is still held in the highest repute for its medicinal qualities in some places, and was formerly much grown in cottage gardens.

Hypericum perforatum, Linn. Not unfrequent, especially along the rivers in the districts visited. Not found in the north of the county.

Geranium sanguineum, Linn. Abundant at St. John's Point. Not found previously in the north of Ireland, excepting two localities in Antrim. On limestone.

G. lucidum, Linn. Sparingly at St. John's Point; by the Erne, about a quarter of a mile above Ballyshannon, on the left bank sparingly; in a thicket below the house at "Cliff," on the right bank near Belleek. On limestone.

**G. pratense*, Linn. In a meadow by the river at Temple Carn Glebe, near Pettigo. I am indebted to Miss Young for this information, but she thinks the plant may have been introduced accidentally from the Glebe garden.

Radiola millegrana, Sm. Coast at Port, near Tormore; at Glen Head; and at the Eagle's Nest, near Malinmore.

Euonymus europæus, Linn. Rooney's island, near Donegal; coast a mile west of Ballyshannon; by the Erne; near "Cliff," Ballyshannon; Lake Gorman; steep banks above the sea near Inver; near Salthill; Doorin Point; bank of Bundrowes river; plentiful at St. John's Point, and in thickets by the Letter river, where it reaches a height of ten to fifteen feet. On limestone.

Rhamnus catharticus, Linn. Near Temple Carn Glebe; Miss Young.

Ulex europæus, Linn. East side of Fintragh Bay; in several places along the Finn river, above Cloghaun bridge. The only native stations I observed; but it would be impossible to decide for or against this plant being indigenous. Not on the limestone.

Trifolium medium, Linn. Banks of rivers and limestone bluffs by the sea, in many places, and often, as at Mucross and St. John's Point, highly ornamental; prefers limestone.

Lotus major, Scop. Rather a common species in this district.

Vicia sylvatica, Linn. This handsome vetch is quite characteristic of Donegal Bay. It occurs at Mucross Point, with maidenhair fern, and *Sedum rhodiola;* abundantly at Inver, on steep banks above the sea near the mouth of the estuary with Euonymus; coast between Killybegs and Fintragh in several places; Fintragh Bay and thence to Largy; between Donegal and Killymard Rectory by the sea.

Prunus padus, Linn. Sparingly in Ardnamona woods; abundant by the river Finn, in many places from Lifford to the Reelan water, as at Drumbo, and below Cloghaun bridge; forming thickets along the Reelan water in some places, and occurring also in the upper reaches of the Finn.

‡*Prunus avium*, Linn. Roadsides and hedges about Pettigo, Killybegs, Dunkineely, and Donegal; probably nowhere native. *P. cerasus*, Linn, also occurs in a half wild state.

**Spiræa salicifolia*, Linn. A colony of about fifteen yards in length, growing on the edge of the Finn water, occurs on its left bank, about a quarter of a mile above Castlefinn bridge, looking thoroughly native, but probably transported thither long since by the river.

Agrimonia eupatorium, Linn. St. John's Point; Eanymore water, below Drumagraa bridge.

Rubus idæus, Linn. By the Eske, Finn, and Erne rivers.

R. saxatilis, Linn. By the Erne, on the left bank near Ballyshannon; St. John's Point, Eanymore water. On limestone.

R. suberectus, Aud. (probably *R. fissus*, Lind.). By the river Finn, and near Pettigo. I am indebted to Mr. Baker for this and the following determinations of the Rubi.

R. discolor, W. & N. St. John's Point, and near Pettigo.

R. subsp. ? *R. calvatus*, Blox. Pettigo.

Dryas octopetala, Linn. Above Lake Agh, Slieve League, at about 1300 feet above sea-level. Very scarce in two small patches with *Polygonum viviparum*. Neither occur elsewhere on Slieve League, and, unlike the other alpine plants, these two appear to be rapidly undergoing extermination at the hands of commoner plants. This species does not occur elsewhere in Donegal, the locality given for district 11 in the *Cybele Hibernica* being a mistake, as Mr. More informs me.

Geum rivale, Linn. Lough Head river near Killybegs; Letter river near Lough Erne; Eanymore water; by the Foyle, below Clonleigh.

Rosa tomentosa, Sm. Commonest rose inland.

R. canina, Linn. Commonest rose by the sea. No remarkable varieties occur.

R. spinosissima, Linn. Sand-hills between Bundoran and Ballyshannon. Shore below Dunkineely.

Pyrus malus, Linn. Roadsides near Pettigo.

P. aucuparia, Gœrt. Reelan Water; Glen river; Inver; Slieve League, &c.

Peplis portula, Linn. Lake Unshagh, near Slieve League.

Epilobium hirsutum, Linn. By a rivulet at Kildoney Point, west of Ballyshannon, and again in a ditch nearer Ballyshannon; by the shore at "The Doon," Malinbeg; roadside between Donegal and Ballyshannon.

E. parviflorum, Linn. Right bank of Erne, near Ballyshannon, two feet high.

| *Myriophyllum spicatum*, Bundrowes river near Bundoran. *M. alterniflorum*, D. C. Is an abundant species.

Sedum rhodiola, D. C. Mucross Point; Glen Head; Slieve League, &c.

**S. reflexum*, Linn. Railway embankment above the Foyle, near Carrigans. Not native.

|†*S. telephium*, Linn. Rooskey, in the parish of Clondahorky, in the north of the county, in shelter of a low wall in a lea field, far

removed from any garden or likely source of introduction, and appearing native. It was discovered here, in 1883, by my friend, the Rev. Alexander Stuart, then rector of Marble Hill.}

Saxifraga stellaris, Linn. Slieve League and other mountains. Not uncommon in Donegal.

S. aizoides, Linn. Slieve League, from 1550 to 1140 feet above sea level, whence it was recorded in the Supplement to the *Cybele Hibernica*. Not found elsewhere in Donegal.

S. tridactylites, Linn. Sandy downs between Bundoran and Bally-shannon; Miss Young.

**S. umbrosa*, Linn. Naturalized by the Letter river and Loughhead river. Not native in this part of Donegal.

S. oppositifolia, Linn. Slieve League, from 1850 to 400 feet; on the sea cliffs of Leahan, a little north of Slieve League, from 600 to 400 feet, or lower; also on the sea-face of Slieve League, amongst heather, at about 800 feet; quite apart from alpine plants in several places.

Eryngium maritimum, Linn. Glen Bay; between Glen and Malin-more.

Apium graveolens, Linn. Shores near Donegal; Inver Bay, near Dunkineely, and several places between that and St. John's Point.

Helosciadium nodiflorum, Koch. Malinmore; Kildoney Point; road-side near Inver, on Killybegs road. Not a common plant in Donegal.

H. repens, Koch. Right bank of the Erne, above Ballyshannon.

H. inundatum, Koch. With the last, and near the mouth of the Bundrowes river, near Bundoran.

**Œgopodium podagraria*, Linn. Not common except as a hateful garden weed; by the bridge at Inver.

Carum verticillatum, Koch. By Lough Eske, at the north-east corner, at the mouth of a rivulet in plenty; an important addition to the flora of Donegal. With the recently discovered *Bartsia viscosa* and the Killarney fern, this plant increases the number of the Atlantic group found in this county.

Pimpinella saxifraga, Linn. Local; shores near Donegal, in several places; Glen Bay; by the Erne, near Ballyshannon.

Sium augustifolium, Linn. In a ditch with *Epilobium hirsutum*, N.W. from Ballyshannon at Kildoney Point; the only place I have seen the plant in Donegal.

Œnanthe lachenalii, Gmel. Shores near Donegal; Ballyshannon; Glen Bay; Fintragh.

Œ. crocata, Linn. By Lough Eske; by the Erne; roadside between Largy and Fintragh; by the Foyle, near Lifford and Clonleigh.

[*Œ. phellandrium*, Linn. "11" is amongst the list of districts after this plant's name in the *Cybele Hibernica;* no authority given, and the plant does not, I think, occur. The river Erne is the only likely place, but I could not find it there.]

Crithmum maritimum, Linn. Malinbeg; Mucross Point; St. John's Point, south side; Slieve League.

Scandix pecten-veneris, Linn. Doorin Point.

‡*Myrrhis odorata*, Hoffm. Old walls at Loughhead, near Killybegs, at the mouth of the river. Anciently introduced. (?)

Cornus sanguinea, Linn. Sparingly on the right bank of the Erne and on the left bank of the Bundrowes river; only on limestone, and native; quite similar to the stunted form on Aran, in Galway Bay, where it is also native.

Valeriana officinalis, Linn.; var. *sambucifolia*, Mikan. Specimens from limestone shingle by the sea, near Mucross Point, Mr. Baker pronounces "clearly var. *sambucifolia*." The form, as I gathered it, is sufficiently distinct.

Viburnum opulus, Linn. By the Eske, Erne, Eany, Finn, Bundrowes, and Letter rivers; damp thickets about Mount Charles; very showy both in berry and flower about the Letter river, near Termon M'Grath's Castle. Prefers limestone.

Asperula odorata, Linn. By the Eany water above Bonny Glen; river between Pettigo and Lough Erne.

Galium boreale, Linn. Plentiful at the extremity of St. John's Point. I formerly gathered this plant near Glen. On limestone.

Eupatorium cannabinum, Linn. Eske and Erne rivers; Bradagh river, near Bundoran; ditch near the sea at Wardtown, near Ballyshannon; Trabane Strand, near Malinbeg; Glen Bay; St. John's Point.

Petasites vulgaris, Desf. Inver; Dunkineely; Fintragh; Finn river; Pettigo.

Aster tripolium, Linn. Glen Bay; Inver Bridge; Donegal to Killymard.

**Aster*, sp.? *A. lævis*? Naturalized from a cottage garden at mouth of Bundrowes river, near Bundoran; not flowering up to August. I have observed the same species (I believe, American) looking like a native by the river Nore above Kilkenny, and again below Woodstock.

‡*Inula helenium*, Linn. Near Ballyshannon; Inver to Dunkineely; Glen; Dunlacky Bridge, near Dunkineely.

Pulicaria dysenterica, Gœrt. Shores on both sides of Donegal; St. John's Point; Inver Bay; Doorin Point.

Bidens tripartita, Linn. Roadside between Carrick and Lake Unna; Glen Bay.

B. cernua, Linn. Near Bundrowes Bridge, Bundoran; by the Foyle, near Lifford, in railway ditches.

‡*Tanacetum vulgaris*, Linn. Inver; St. John's Point, &c.; not very scarce, and established; an escape from cottage gardens.

Filago germanica, Linn. Sand-hills south of Carrickfad, between Donegal and Ballyshannon.

Gnaphalium uliginosum, Linn. Pettigo; by the Erne, right bank; &c.

G. sylvaticum, Linn. N. E. shore of Lough Eske; by the Finn, above Drumbo; between Ballyshannon and Bundoran.

Antennaria dioica, Gœrt. Common on mountains. Seashore at Bell's Isle, S.W. from Donegal; shores of Lough Eske.

**Senecio saracenicus*, Linn. Established by the river between Pettigo and Lough Erne.

Saussurea alpina,[5] D.C. Slieve League, 1600 to 1330 feet above sea level. The second locality in the county; found by me previously at Bulbin mountain.

Carlina vulgaris, Linn. St. John's Point, sparingly. The second northern locality, "Ballycastle, Antrim," being the other.

Centaurea cyanus, Linn. Fields by the Finn, in several places.

{‡*Cichorium intybus*, Linn. In a field near the south shore of Inch Island, in Lough Swilly, where it was found by Mrs. Bohen's gardener, of Burt.}

Thrincia hirta, D.C. Sea coast on limestone bluffs, a couple of miles S.W. from Donegal; shore of Lough Eske, at the south-east end. Only on limestone, and very rare in Donegal.

Sonchus asper, Hoffm. Fintragh Bay.

Crepis virens, Linn. Doorin Point to Salt Hill, and elsewhere abundant.

C. paludosa, Moench. Eske, Erne, Bradagh, and Finn rivers; Slieve League.

Amongst a series of Irish hawk-weeds, kindly determined for me by Mr. James Backhouse, the following are from the county Donegal. I have bracketed those not found in the district under consideration:—

Hieracium cerinthoides, Back. (*H. anglicum*, Fr.), *a*, Slieve League;

[5] My friend, the Rev. Dr. Gwyn, informs me that Mr. Colgan, a friend of his, has found Saussurea on Slieve Snacht, near Gweedore, this year (1884).

β, St. John's Point; rocks near the sea at Ballyshannon; Slieve League.

H. iricum, Fr. Slieve League; river Finn; Killybegs river; {Coolcross, Innishowen.}

H. pallidum, Fr.? Slieve League; specimens insufficient for certainty.

H. argenteum, Fr. Carrick river. Mr. Backhouse and Professor Babington, to whom the former desired me to forward my specimens, both agree about this plant, which has not been detected in Ireland hitherto. I have it also from Connemara and Down. Specimens from Glenalla, in Donegal, are doubtfully referred to this species.

{*H. cæsium*, Fr. Coolcross, Innishowen.}

H. vulgatum, Fr.? River Finn; specimens imperfect, but "probably this species."

H. gothicum, Fr. Killybegs river; river Finn.

H. gothicum, Fr.; *β*, *latifolium*, Backh. Killybegs river; Carrick river.[6]

H. umbellatum, Linn. Carrick river; Lough Eske, "near var. *filifolium*," Lough Eske, and banks of all the rivers visited in south-west Donegal except the Erne.

{*H. crocatum*, Fr. Glennagiveney, Innishowen.}

Lobelia dortmanna, Linn. Lough Eske; Lough Agh, Slieve League; Lough Avehy, and other lakes between Pettigo and Ballyshannon.

**Campanula latifolia*, Linn. A couple of plants by the Letter river, where it flows into Lough Erne; but I was able to trace their origin to a garden a little way up stream.

Arctostaphylos uva-ursi, Spr. Abundant on the sea-face of Slieve League from the sea to the summit.

Vaccinium vitis-idæa, Linn. Banagher mountain, west of Lough Eske, at 1100 feet; from close to the top of Slieve League down to 1400 on the north side.

**Vinca minor*, Linn. Established by the Letter river near Lough Erne; an outcast from a garden.

Gentiana amarella, Linn. Plentiful on the sandy downs between Ballyshannon and Bundoran. Not met with elsewhere in Donegal. *G. campestris*, Linn., is common.

Convolvulus arvensis, Linn. Abundant in fields between the old coastguard watch-house and the Blind Rock, on the eastern shore of Doorin promontory. Very rare in Donegal.

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[6] Of the plants from Carrick river, Mr. Backhouse was doubtful, and wrote, "heads far too numerous for *gothicum*;" he wrote also, "like *H. norvegicum*, Fr.," and requested me to send the specimen to Professor Babington, who placed them as above.

‡*Symphytum officinale*, Linn. Eanymore water, above Drumagraa Bridge; elsewhere near cottage gardens.

**Borago officinalis*, Linn. Occurs occasionally, as by Lough Eske, but an escape from cultivation.

{†*Echium vulgare*, Linn. In a field on the south side of Inch Island, where it was gathered by Mrs. Bohen's gardener, of Burt, Lough Swilly.}

**Lycium barbarum*, Linn. Established by the Bundrowes river, near Bundoran, having spread from a cottage garden.

‡*Solanum dulcamara*, Linn. By an inlet a couple of miles S.W. from Donegal, along the shore, but near a cottage. At Ballyshannon, this plant may be seen trailed over cottages for ornament, showing its means of introduction; roadside by the workhouse near Donegal.

**Linaria cymbalaria*, Mill. Roadside walls about Ballyshannon.

Scrophularia aquatica, Linn. By the Pettigo river, close to its mouth at Lough Eske.

**Mimulus luteus*, Linn. Malinmore; about Carrick; very abundant and ornamental along the Foyle, from Lifford to Carrigans, where it more than holds its own amongst the coarsest marsh plants.

Veronica scutellata, Linn. By the river Eske; Ardnamona woods; Crumlin lough, near Killybegs.

V. anagallis, Linn. Roadside between Donegal and Ballyshannon; Bundrowes bridge, Bundoran.

V. beccabunga, Linn. Glen.

**V. peregrina*, Linn. White-house garden, Killybegs; Lough Eske Castle garden, and apparently as a weed in most of the gardens throughout the country. I have noticed its abundance fifteen years ago in Donegal and Derry gardens.

**Mentha viridis*, Linn. On the left bank of the Finn, immediately above Liscooly Bridge; thoroughly established, and quite apart from any existing cottage or garden.

**M. piperita*, Sm. Roadside waste places between Tawnamully Bridge and Lough Eske; between Ballyshannon and Donegal; by the Bundrowes bridge, Bundoran; an established escape from cottage gardens.

Scutellaria galericulata, Linn. Right bank of the Erne, about a mile above Ballyshannon, at the point where Donegal touches Lough Erne; on limestone shingle in a little stony bay (Port Roshin?) between Killybegs and Fintragh—an odd situation; but I have seen it in exactly similar ones in Kerry, between Castletown Bere and Adrigoole.

Galeopsis versicolor, Curt. Fields about Ballyshannon and Ballintra.

Verbena officinalis, Linn. Gathered for several years in one place close to Termon M'Grath's Castle, on the confines of the county, near Pettigo, by Miss Young.

Utricularia vulgaris, Linn. In deep holes by the stream at Bunlin Bar, between Donegal and Ballyshannon; lakes between Cavan Garden and Brown Hall; Crumlin lough, near Killybegs; railway ditches by the Foyle, between Lifford and Clonleigh.

U. intermedia, Hayne. Holes by the river Eske; bog-holes about Lake Unshin, Lake Golagh, &c., west of Ballyshannon, abundant, and extending into Fermanagh (District 10); bog-holes between Carrick and Glen, on both sides of the road. I have observed this species for several years in Ireland, but not yet seen the flowers. The buds, or hybernacula, are always to be found in August and September.

U. minor, Linn. Bog-holes about Breezy Hill, west of Ballyshannon; lakes between Cavan Garden and Brown Hall; bog-holes between Carrick and Glen, on both sides of the road.

Lysimachia vulgaris, Linn. Frequent along the river Erne, at the point where Donegal touches Lough Erne; by Bundrowes river, near Bundoran.

Statice bahusiensis, Fries. Rocks on the strand, between the stream and the land, at the north-east corner of Fintragh Bay, where it was discovered by Miss Brook of Killybegs; in one place between Rossylongan and Donegal, below the first residence by the shore after leaving Donegal. The northernmost point on the west coast at which I have met this plant previously lies under Croaghpatrick, in Mayo.

S. occidentalis, Lloyd. On rocks at the signal tower on the mainland abreast of Rathlin O'Beirne's Island, west of Slieve League. Found only in two other localities in Donegal in the north of Ireland.

**Chenopodium bonus henricus*, Linn. Near Belleck, by the Erne.

**C. album*, Linn. Shore at Ballyweal, near Donegal, and elsewhere in tilled land.

Suæda maritima, Dum. Shores near Donegal, Killybegs, and Inver.

Salsoli kali, Linn. Trabane strand, near Malinbeg; Tawny Bay, near Carrick.

Beta maritima, Linn. Trabane strand; Malinmore to Glen.

Salicornia herbacea, Linn. Shores about Donegal and Killybegs.

Atriplex angustifolia, Sm. Shore near Donegal, and at Rooney's Island; Inver; St. John's Point.

A. hastata, Linn. St. John's Point, south side. *A. babingtonii*, Linn. Sea-shores; abundant.

Rumex hydrolapathum, Huds. In several places from one to two miles up the right bank of the Erne from Ballyshannon, and again at "Cliff" nearer to Belleek. The only localities in Donegal.

Oxyria reniformis, Hook. Slieve League, from 1550 to 1000 feet above sea level. The second locality in the county; found by me previously at the Poisoned Glen.

Polygonum viviparum, Linn. Slieve League, at about 1300 feet above sea level in one place only. The second locality in the county; found previously by me at Bulbin Mountain in Innishowen.

P. raii, Bab. Trabane strand, near Malinbeg; coast of Inver Bay, below Dunkineely; shore near Bundoran.

Euphorbia portlandica, Linn. Sand-hills south of Carrickfad, between Donegal and Ballyshannon; near Ballyshannon to north-west; between Ballyshannon and Bundoran.

{*Parietaria diffusa*, Koch. Walls of Culmore Fort, Dean Gwyn.}

†*Salix pentandra*, Linn. Abundant in upland districts, especially about Pettigo, Donegal, and Ballyshannon; also along roadsides, and so often used for holding bog ditches together, that it is hopeless to determine whether it is native or not. My impression is that it belongs to the country, but has been long utilized. It is quite characteristic of some streams, as between Pettigo and Lough Erne, where it is 25 to 30 feet high.

‡*S. purpurea*, Linn. Mouth of Loughhead river, near Killybegs.

S. herbacea, Linn. Slieve League, from near the summit to 1500 feet above sea level.

Quercus sessiliflora, Salisb. "Cliff," by the Erne, near Belleek.

Juniperus communis, Linn. Right bank of Erne, between Ballyshannon and Belleek; *J. nana*, on Bulbin mountain, near Ballyshannon; abundant on limestone hills, Ballyshannon to Brown Hall; sea cliffs, Slieve League, Malinbeg, and Killybegs to Fintragh.

?*Hydrocharis morsus-ranæ*, Linn. Near Pettigo, Miss Young; but whether in Donegal or Fermanagh I have not as yet ascertained.

**Elodea canadensis*, Rich. Plentiful in the Erne, between Ballyshannon and Belleek.

Gymnadenia conopsea, R. Br. By the Erne; between Cavan Garden and Brown Hall; Tawny Bay.

Listera ovata, R. Br. Rooney's Island, near Donegal; Glen Bay and Fintragh bog; amongst alpine plants on Slieve League, at 1470 feet.

L. cordata, R. Br. Slieve League, in several places.

Habenaria viridis, R. Br. Shore near Ballyshannon; Doorin Point; St. John's Point. Probably frequent. *H. bifolia*, R. Br. At Glen Bay, &c.

Epipactis latifolia, All. The Hall, Mount Charles; Ardnamona; three feet high at Lough Eske Castle woods; variable in shape of leaves.

E. palustris, Linn. Plentiful in a glade in the Ardnamona woods.

Cephalanthera ensifolia, Rich. I gathered this at Ardnamona, where it was originally discovered by Mrs. Brooke, of Lough Eske.

Allium ursinum, Linn. Lough Eske Castle woods; Brown Hall; by the Eanymore water, on the left bank below Drumagraa Bridge.

**A. babingtonii*, Wood. Established on the coast of Inver Bay, north side.

Juncus glaucus, Ehrh. About Donegal, Ballyshannon, Killybegs, Dunkineely, Bundoran, and by the river Erne.

J. obtusiflorus, Ehrh. By "Washpool" stream, a little north of Ballyshannon; edges of lake north of Cavan Garden. On limestone.

?*Luzula pilosa*, Willd. Lough Eske Castle wood. I believe it was this species, but the specimens gathered were withered.

Typha latifolia, Linn. Brown Hall, near Bundoran; by the Foyle, near Lifford; Lake Unshagh, near Slieve League.

Sparganium simplex, Huds. Lake Unshagh and Lough Eske.

S. minimum, Fries. Lake Golagh, and other lakes west of Ballyshannon; lakes Unna, Dina, Agh, &c., near Carrick; Lough Avehy, near Pettigo.

Arum maculatum, Linn. Frequent about Pettigo, Bundoran, Belleek, Ballyshannon, and Donegal; almost confined to the limestone and to this part of Donegal.

N.B.—Mr. Arthur Bennett kindly examined my pond weeds. To him the following (marked A. B.) decisions are due:—

{*Potamogeton polygonifolius*, Pourr. River Lennan at Rathmelton; a long-leaved, usually barren form, A. B.}

P. rufescens, Schras. Lough Unshagh, near Slieve League, A. B.

P. zizii, Roth. Letter river, near Pettigo, A. B.

{*P. decipiens*, Roth. Long lough, near Fort Royal, Rathmullan, A. B.}

P. lucens, Linn. Lough Eske and river Eske; Bundrowes river, near Bundoran.

P. perfoliatus, Linn. Erne, near Ballyshannon; Bundrowes river, near Bundoran; Lough Avehy and other lakes near Pettigo; Islandmore in the Foyle.

P. heterophyllus, Schreb. Lake Laghtowen, near Pettigo; river Eske.

P. crispus, Linn. Bradagh river, near Bundoran.

Ruppia maritima, Linn. Glen Bay; salt marshes, near Donegal and Ballyshannon.

Schœnus nigricans, Linn. *Cladium mariscus*, R. Br.; and *Rhychospora alba*, Vahl, frequent.

Scirpus pauciflorus, Lightf. Shores of Lough Eske, east side; margins of lakes, on limestone north of Cavan Garden; St. John's Point; by the shore between Donegal and Killymard.

S. fluitans, Hook. Lake, near Breezy Hill; Lough Erahesk and ditches about L. Laghtowen, near Pettigo.

S. setaceus, Linn. By the Eske, Lough Eske, &c.

S. savii, Schm. About Loughs Eske and Shivnagh; coast between Malinmore and Glen; along the Finn, above Stranorlar.

Blysmus rufus, Pam. Shores at Donegal, abundant; Fintragh; Killybegs; Lough Head, near Killybegs.

Carex dioica, Linn. Shores of Lough Gorman, between Cavan Garden and Brown Hall; about the base of Slieve League.

C. pulicaris, Linn.; *C. disticha*, Huds.; *C. arenaria*, Linn.; *C. vulpina*, Linn.; *C. paniculata*, Linn. Not unfrequent.

C. bœnninghauseniana. By a sunk fence between the Hall and the sea wall, near Mount Charles, in company with *C. strigosa*, *C. remota*, &c. Not hitherto detected in Ireland. My specimens were recognized by my friend, A. G. More, who tells me that this form is usually regarded as a hybrid between *C. remota* and *C. paniculata*. I have no note of *C. paniculata* in this particular spot. *C. remota*, Linn.; *C. stellulata*, Good, frequent.

C. ovalis, Good. By the Eske above Donegal.

C. curta, Good. Near Killybegs, A. G. More.

C. rigida, Good. Slieve League, summit to 1400 feet.

C. pallescens, Linn. Above Ardnamona. *C. vulgaris*, Fries.; *C. panicea*, Linn, frequent.

C. limosa, Linn. Marsh on east side of Bulbin Mountain, near Ballyshannon; Lake Unshin; bog-holes between Glen and Carrick on both sides of the road; lakes, near Killybegs.

C. strigosa, Huds. This rare sedge is abundant about the Hall, Mount Charles.

C. pendula, Huds. Right bank of Eske river, three-quarters of a mile above Donegal; left bank of Eanymore water, and above Drumagraa bridge.

C. aquatilis, Wahl. I have gathered this sedge by the river Finn in several places, and also, I believe, by two other rivers in south Donegal. My specimens were recognized as *C. aquatilis* by A. G. More, and afterwards corroborated by Mr. A. Bennett. This sedge has only been added to the Irish Flora from Lough Allen

by Mr. Stewart in the present year. The Donegal plant differs somewhat from Mr. Stewart's, but both appear, according to Mr. Bennett, to belong to the lowland form *watsoni*.

C. præcox, Jacq.; *C. pilulifera*, Linn.; *C. glauca*; *C. flava*, and *C. extensa*, Good, frequent.

[" *C. acuta*, Linn. Banks of the Finn, Admiral Jones," *Cybele Hibernica*. Was, I believe, *C. aquatilis*.]

C. hornschuchiana, Hoppe. By the Eske, above Donegal; Cavan Garden; lakes north of Ballyshannon. *C. distans*, Linn.; *C. binervis*, Sm., frequent.

C. lævigata, Sm. Woods about Lough Eske castle; abundant.

C. sylvatica, Huds. River Eske; Brown Hall; Eany water; Pettigo river, &c.

C. filiformis, Linn. West side of Lough Eske, abundant in two places; Laree lake, Lough Unshin, and L. Golagh, west of Ballyshannon, extending to District 10; lakes north of Cavan Garden; Cunlin lake, near Killybegs; south-east corner of Lough Eske; Lough Avehy. *C. ampullacea*, Good. Common.

C. hirta, Linn. River Eske; Ballyshannon to Bundoran; Ardnamona.

C. vesicaria, Linn. Left bank of Erne, above Belleek.

C. riparia, Curt. By the stream at Bunlin Bar, along the coast between Donegal and Ballyshannon. The locality is a little north of Carrickafad, in a deep ditch; marsh at St. John's Point.

N.B.—I have given the Carices in some detail, as this family is unusually well represented in this part of the county.

Phleum arenarium, Linn. Glen Bay; between Ballyshannon and Bundoran.

P. pratense, Linn. By the Finn, a little below Castlefinn bridge.

Alopecurus geniculatus, Linn. Lough Unshagh, near Carrick; by the Erne.

Sesleria cærulea, Scop. Rocks on south side of inlet below Ballyshannon, the only locality given in the *Cybele*. Abundant on limestone hills between Ballyshannon and Bundoran, and from Ballyshannon to Cavan Garden; about Lough Gorman, and thence to Brown hall; St. John's Point, and on the promontory leading to it, plentiful; by the Eanymore water, in several places, reaching up to the skirts of the Bluestack mountains, but at no great elevation; south-east shore of Lough Eske; banks by the sea, a little north of Bundoran. Always on limestone.

Milium effusum, Linn. Ardnamona woods, Lough Eske; left bank of Eanymore water, below Drumagraa bridge.

? *Holcus mollis*, Linn. Thickets on sandhills by the sea, north-east end of Inver Bay. The specimens were in a withered state.

Koeleria cristata, Pers. With the last, and also in many places on Slieve League.

Melica uniflora, Retz. By the Eske, Erne, and Letter rivers; Brown Hall.

Sclerochloa loliacea, Woods. Glen Bay.

Festuca sciuroides, Roth. Doorin Point; roadsides near Pettigo.

F. sylvatica, Will. By the Eske, above Donegal, right bank.

F. gigantea, Will. By the Erne, left bank, and Finn, at Killygordon.

F. arundinacea, Schreb. Eske river; Inver Bay.

Bromus asper, Linn. By the Erne.

? *B. commutatus*. Left bank of Finn, between Stranorlar and Killygordon. My specimens were too withered to be positive of the species.

Triticum caninum, Huds. Left bank of Erne, a little below Belleek; at "Cliff," and near it, extending across boundary to District 10.

T. acutum, D. C. Glen Bay and Inver Bay.

T. junceum, Linn. Tawny Bay and Glen Bay.

Elymus arenarius, Linn. "Rinn of the Largy," and again a little west of it, beyond Killybegs.

Lepturus incurvatus, Linn. Inver Bay, near Dunkineely; Killybegs; Donegal.

**Lolium temulentum*, Linn. By the Finn, near Clady; sown.

Equisetum maximum, Lam. Frequent around Donegal Bay.

E. sylvaticum, Linn. Eske, near Donegal; Salthill; Reelan water.

E. variegatum, Schleich. By the Eske, above Donegal; and by Lough Eske, between Ardnamore and the Castle, with an erect variety, apparently *E. mackaiana*.

E. hyemale, Linn. By the right bank of the river Eske. "Like *E. moorei*," Baker writes to my specimens.

Polypodium vulgare, Linn. Var. *semilacerum*. By the Erne, at "Cliff."

P. phegopteris, Linn. Killybegs, sparingly in several places, A. G. Brooke; Ardnamona and Lough Eske Castle woods; Banagher mountain.

Lastrea thelypteris, Presl. By the Erne. A. G. More.

L. oreopteris, Presl. Banks of Eske, Glen river, Lough head river, Reelan water, &c. *L. filix mas.*, Presl.; *L. dilatata*, Presl.; *L. æmula*, Brack. Frequent.

L. spinulosa, Presl. Woods at Lough Eske. A form of *L. dilatata*.

Polystichum lonchitis, Roth. Slieve League, 1850 to 1470 feet; previously reported, incorrectly, from Donegal in other places. Having explored these localities, I have now the satisfaction of restoring it legitimately to its place in the list.

P. angulare, Newman. Largy; Lough Eske.

P. aculeatum. Roth. Lough Eske and river Eske; Loughhead river; Eanymore water; Finn, near Cloghaun bridge.

Cystopteris fragilis, Bernh. By the Erne, near Ballyshannon; Brown Hall; Slieve League. *Athyrium filix fœmina*, Roth; *Asplenium adiantum-nigrum*, Linn. *A. trichomanes*, Linn. Frequent.

Asplenium viride, Huds. 1550 feet (and higher?) to 1200 feet on Slieve League.

A. marinum, Linn. Malinbeg; Mucross Point; Glen Head.

A. ruta-muraria, Linn. Walls at Donegal, Lough Eske Castle, and Laghy; rocks by the right bank of the Erne; by Loughhead river, near Killybegs; St. John's Point.

Scolopendrium vulgare, Sm. *Blechnum boreale*, Sw.; *Pteris aquilina*, Linn; frequent.

Ceterach officinarum, Willd. Garden walls at Brown Hall, where I am informed by Mr. Brook, of Killybegs, it is abundant.

Adiantum capillus veneris, Linn. Slieve League, at Bunglass; Tawny Bay to Teelin Bay; Teelin Bay to Mucross Point.

Trichomanes radicans, Sw. Ardnamona woods. Killarney fern has also been discovered this year in Donegal, at the Poisoned Glen.

Hymenophyllum tunbridgense, Sw. Lough Eske woods. *H. wilsoni*, Hook; *Osmunda regalis*, Linn.; common.

(*Botrychium lunaria*, Sw. My visits have been too late for this plant; it is almost certain to occur on some of the bluffs by the sea, as along Fintragh and St. John's Point.)

Ophioglossum vulgatum, Linn. Close to Lough Eske Castle, Miss Young.

O. lusitanicum. Carrigan Head.

N.B.—Ferns have been enumerated at length to show how rich the district is; almost all the group as represented in Ireland occur.

Isöetes lacustris, Linn. Lough Esk; lakes near Lough Erahesk; Lough Agh, and other lakes.

Lycopodium clavatum, Linn. Mountains near Pettigo, Miss Young. Greenane.

L. alpinum, Linn. Slieve League, near the summit.

L. selaginoides, Linn. Rocky headlands, sandy shores, and higher mountains in wet places; frequent. *L. selago*, Linn., frequent.

I will now briefly enumerate the species which have not previously been gathered in the county Donegal. I will first, however, have the less pleasant duty of expunging, or at least casting a strong suspicion

on a few which occur under District 11 in the *Cybele Hibernica*. These are *Ranunculus lingua*, *Œnanthe phellandrium*, *Scirpus sylvaticus*, and perhaps *Carex acuta*. A few others, of whose occurrence I have received information, I will only record doubtfully, until certified by myself according to the rule I have adopted. These are *Rhamnus catharticus*, *Geranium pratense*, and *Hydrocharis morsus-ranæ*, which Miss Young has observed in the neighbourhood of Pettigo. A considerable number of species which are obviously introduced need not here be repeated. I might add to this list *Echinospermum lappula*, a ballast weed which occured near the quay at Donegal. These species are already mentioned, and may be singled out by their asterisks. The following are additions to District 11, or county Donegal:—

Ranunculus baudotii,	Lysimachia vulgaris,
Cochlearia danica,	Statice bahusiensis,
Geranium sanguineum,	Rumex hydrolapathum,
G. lucidum,	Quercus sessiliflora,
Euonymus europæus,	Juncus obtusiflorus,
Dryas octopetala,	Potamogeton zizii,
Carum verticillatum,	Carex bœnninghauseniana,
Sium augustifolium,	C. aquatilis,
Cornus sanguinea,	C. pendula,
Carlina vulgaris,	C. vesicaria,
Thrincia hirta,	C. riparia,
Hieracium pallidum,	Milium effusum,
H. cæsium,	Triticum caninum,
H. gothicum,	Equisetum hyemale,
H. argenteum,	E. variegatum,
Gentiana amarella,	Polystichum lonchitis;

and *Trichomanes radicans*, the Killarney fern, in its second Donegal locality, may again be mentioned. Of a few others I am still in some degree of doubt. *Orchis morio*, *Festuca myurus*, and *Bromus commutatus* were I think gathered, but the specimens were past flowering.

In conclusion, I have the pleasure to express my sincere thanks to the several botanists who have kindly aided me in determining my specimens: to Mr. More, for his constant help, without which help an Irish botanist can hardly succeed; to Mr. Backhouse, for his valuable discrimination of a long series of Hieracia from various counties; and to Professor Babington for his further supervision of some of that difficult genus; to Mr. Arthur Bennett for very material assistance in several sets of aquatic weeds; and to Mr. Baker for the determination of a few Rubi, and one or two other troublesome forms. To all these gentlemen I desire here to acknowledge my gratitude for their ungrudging assistance.

XXII.—Metamorphic Action. By G. H. Kinahan, M.R.I.A., &c.

[Read, February 23, 1885.]

For years it has seemed to me that certain phenomena in connexion with the metamorphism of rocks have not met with the consideration due to them. In deference to my fellow-labourers in America, but especially in the Dominions, I have not hitherto put these forward; but now, after having seen the Canadian Laurentians, I venture to do so.

By way of introduction, it should be mentioned that metamorphic action may be generally placed under three classes[1] :—

Regional (metapepsis).—Change due to action invading more or less considerable areas. Its exact genesis is at present somewhat obscure. Some suggest that it is due to aqueo-igneous action, or heat in the presence of moisture, generated by a superincumbent mass of accumulations. According to some chemists, if the time be sufficiently long, the change may take place under the given conditions without the intensity of the heat being at any time great.

Contact (paroptesis).—This action invades restricted, generally small, areas or tracts, in immediate contact with intrudes of eruptive rocks or vents for heated gases. It is evidently due to heat generated by them.

Chemical change (methylosis) is more especially the change at or near the surface of the earth, that is, from without.

All rocks, no matter of what kind or of what age, are liable to be affected by one or more of these kinds of metamorphic action, any one of which may affect the rocks before or after the others; but the order in which they more commonly appear to occur is: first, contact; second, regional; and afterwards, chemical change from without. They may, however, occur so confusedly that, in places, the order is more or less obscure. Therefore, to simplify matters, we shall at the present time only consider the effects that regional metamorphic action *alone* would produce.

Any region or area of rock-masses may be subjected successively to two, three, or more invasions of regional metamorphosis. For example, a tract of Cambrian rocks may have been under such conditions that they are metamorphosed; while subsequently these conditions were removed, to be succeeded by others, the latter again affording the conditions of further metamorphic action; and this may be repeated over and over again: so that the same rocks

[1] This has been already stated in chapters x. and xi. of my *Geology of Ireland*, to which I would call attention, as names used hereafter; also details in regard to metamorphic action, will be found therein, which it appears unnecessary to repeat here.

may be at certain times under the influence of metamorphic action; while at other times the same area of rock-masses may be at or near the surface of the earth, and so removed from metamorphic action; the limit of the number of distinct times the rock-masses underwent metamorphism being the number of separate times when they were buried under a sufficient thickness of accumulations to bring about conditions favourable to the different invasions of metamorphic action. This leads to the question, *What effect or effects would each of these distinct aggressions of metamorphic action have on the rocks?*

The different degrees of alteration that rocks exhibit in some metamorphic areas appear to suggest that, in an area of regional metamorphism, the action may be much more intense about certain centres than elsewhere; so that, in such areas, rocks will be found graduating continuously from unaltered through "sub-metamorphic rocks," schist, and gneiss, into granitic gneiss and metamorphic granite. It therefore appears allowable to suggest that each successive accession of metamorphic action into a larger or smaller portion of a tract of rocks will intensify the preceding effects of metamorphism respectively; and if the intensity of the metamorphic action is about the same at each return of it, the changes due to each will be somewhat similar to those in a district like that just mentioned; that is, sub-metamorphic rocks will be changed into schist, schist into gneiss, gneiss into granitic gneiss; but granitic gneiss will become more coarsely crystalline, the plates of aggregated crystals of each mineral becoming larger and more conspicuously developed. If the action be not intense enough, the granitic gneiss cannot be changed into metamorphic granite; while, on the other hand, metamorphic granite may change into granitic gneiss by foliation being developed in it; as, for instance, the metamorphic granite of Galway, if subjected to metamorphic action, should change into a coarse gneiss, like the "Labradorians" of Ha-Ha Bay, province of Quebec.[2]

From the literature of the subject, it would appear that many observers, otherwise good geologists, have a vague idea that metamorphic rocks must have been originally sedimentary or allied rocks, more especially those that now have a marked schistose or gneissose foliation. Such a supposition, however, must be more or less modified, as on examination it will be found that, associated with all sedimentary rocks, no matter what their age, there may be found as adjuncts greater or less intrudes of granitic, felspathic, or basic eruptive rocks, which necessarily will be metamorphosed along with the sedimentary rocks. Also, mature consideration will demonstrate that even independent tracts or areas of granite, felstone, or whinstone, if placed

[2] Rocks, according to their chemical composition and physical properties, are unequally affected by metamorphic action. This must be understood, as it is too long a subject to be entered into here. Therefore, in the sub-metamorphic rocks and schist, subordinate gneiss will probably be found; while in the gneiss, granitic-gneiss, and even the metamorphic-granite, there may be subordinate schists.

under conditions favourable for the development of metamorphic action, must, more or less similarly to sedimentary rocks, be altered, according to their susceptibilities into schist, gneiss, or granitic-gneiss. Examples of granite changed into gneiss are hereafter given; while the change from gabbro and other whinstone into schist and gneiss can be studied in most areas of metamorphic rocks.

A good field for examining the relations between metamorphosed sedimentary and eruptive rocks is found in Yar Connaught on western Galway. Here, to the south of the Clifden and Oughterard valley, there is to the westward a rock-tract, in part sub-metamorphic and in part schist, made up of altered sedimentary rocks and their associated eruptive rocks. This association of rocks, as followed eastward, becomes more and more gneissoid, till eventually all lose their individuality, and become merged into the granitic-gneiss and the metamorphic-granite of the barony of Moycullen. Also, in Yar Connaught and the neighbouring county of Mayo, are exhibited good examples of intrudes of felspathic rocks changed in part into schist and in part into granitoid rocks; while elsewhere are masses of basic eruptive rocks which, when altered, change into different kinds, ranging from hornblendite (hornblende-schist) to syenite and hornblendic-granite.

It is not necessary that each successive invasion of regional metamorphism should act solely on that previously affected. On the contrary, in some cases the newer action affects larger areas; but more usually it appears to be confined to smaller limits. The latter, however, may not be correct; because if, adjoining a tract of more altered rocks, there are less altered ones, it is apparent that the first invasion may have affected the small area, and the second the larger one, or *vice versa*. In some cases, however, the weight of evidence would suggest that the smaller areas are due to the effects of the later invasion, as in them there are fewer faults and other breaks, many having been sealed up during the newer invasion.

Rocks successively altered, whether by regional or contact metamorphism, separately or combined, or even by methylotic action, have, in general more or less marked, often hard boundaries; in the latter cases, as if the action had been stopped or limited by faults on some such lines. Such hard, abrupt boundaries have led different observers to consider the more altered rocks to be older than those with which they are associated; while, in most instances, consideration and examination would prove the opposite to be correct, as *the action which has given the more altered rocks their present strongly-marked characters took place at a time long subsequent to the accumulation of the adjoining rocks, which at the present time are less altered.*

The sections across the tracts of the more altered Irish rocks are so very similar, that the following may be given:—*First*, schist, with subordinate limestone; *second*, alternations of schist and gneiss; *third*, gneiss, with subordinate schists; *fourth*, granitoid-gneiss (*that is, a granitic rock in which the gneissoid characters are well marked*), with a few subordinate beds of schist and perhaps limestone; *fifth*,

metamorphic-granite, with a few subordinate schistose beds and sometimes limestone; *sixth*, gneissic-granite (*that is, a rock that, although foliated, partakes more of the granite than gneiss characters*), with alternations of schist; *seventh*, schist and limestone. It seems remarkable that where sections occur, showing the rocks at each side of a mass of metamorphic-granite, both sections are rarely similar; as on one side the gradation may be gradual, while on the other side it is abrupt. This is the case in Galway, Mayo, Sligo (?), and Donegal: in the last there is a schistose zone in No. 5. The gradual and abrupt gradations seem, in most cases, to be due principally to the chemical composition and physical properties of the original rocks, as some are much more susceptible of sudden change than others.

Intrusions of granite, felstone, whinstone or allied rocks, at their genesis, must have had more or less well-defined boundaries; and, although younger than the rocks in which they occur as intrudes, may, in a great measure, underlie them.[3] If such intrudes are subsequently metamorphosed, but at the same time as the associated rocks, they necessarily will retain the original hard boundaries; which probably may become even more marked, as the rocks of the intrude will change into a rock more or less different from those into which the associated sedimentary rocks are changed; as *all eruptive rocks in the early stages of metamorphism are more prone to change into some of the varieties of gneiss or granitic rocks than into varieties of schist; while most sedimentary rocks, if subjected to a similar degree of metamorphic action, will be changed into schists.*

Such very different results of metamorphic action, which can be seen in nearly every tract of metamorphic rocks, let them be small or large, seem to be a stumbling-block to many observers, who will insist that such tracts of more conspicuously developed rocks, on account of their distinct character and hard boundaries, must be older than the associated rocks.

Apparently it is an anomaly to suggest that any gneiss could originally have been granite. Yet that such is the case can be proved even in a small island like Ireland. To give two examples:—The Slieve Croob granite, county Down, was intruded into the Cambro-Silurian; and although in general a mass, yet from it, in places, there were branches, principally veins of four or five inches to many feet wide. Subsequently, a tract of country along the line of the margin of the granite intrude (including a strip of the granite and a strip of the adjoining rocks) was subjected to an invasion of metamorphic action, which changed the granite affected into gneiss, while

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[3] Such *intrudes* must not be confounded with pre-existing hills or *protrudes*; as the latter, although made up of rocks very similar in general character, existed before the sedimentary rocks were deposited, the latter accumulating around and on them. Intrudes and protrudes, in general, can be easily distinguished, as the former nearly invariably sends courses, branches, or veins into the associated sedimentary rocks, while a protrude does not, it often having a conglomeritic or brecciated rock in part margining it.

the adjoining sub-metamorphic rocks became well-developed schists. In the metamorphic area of the Castlebar district, county Mayo, it is evident that, prior to the latest invasion of metamorphic action, there were intrudes of granite, partly in masses and partly in wide courses, the last invasion changing these intrudes into a granitic-gneiss.

The above suggestions and statements are, for the most part, solely confined to the effects due to regional metamorphism, unaided by either of the other kinds. It must, however, be remembered that such a supposition can be solely provisional, as the majority of the intrudes of eruptive rocks had, as adjuncts, tracts of rocks affected by contact metamorphism; while certain rocks, if raised sufficiently near or to the earth's surface, must have come under the influence of methylitic action; while all rocks, in any way changed by either of these actions, must more or less influence any subsequent regional metamorphism, and thereby introduce numerous complications—a subject of such extent that it cannot here be entered on.

XXIII.—PRELIMINARY REPORT ON THE FUNGI OF GLENGARIFF AND KILLARNEY. By GREENWOOD PIM, M.A., F.L.S.

[Read, February 23, 1885.]

EARLY in 1883 the Academy were good enough to grant me a sum in aid of the investigation of the Fungi of Glengariff and Killarney. In accordance therewith, I proceeded to the former towards the end of September of that year, and after spending some days, and collecting a considerable number of species, went on to Killarney. The summer had been rather a wet one and unfavourable to the development of fungal mycelium, and whilst there the weather was so bad as to render collecting very difficult. [Moreover, domestic trouble necessitated my return long before I had explored the district as I could wish.] A second visit to Killarney was made last autumn under much more favourable circumstances.

Investigating the mycology of any district differs essentially from the study of almost every other branch of its flora, inasmuch as in most instances the plants are extremely evanescent—appearing to-day, and within a day or two leaving no trace, save perhaps a little brown or blackish slime. Hence it is evident that, unless the explorer is present at the exact time a given species appears, he has no means, in many instances, of even guessing at its existence. Again, especially amongst the Agaricini, the species are so variable and so difficult to identify with certainty, especially when one has no competent person to consult with, that it is quite possible in some instances the same species has been referred to different names, and, conversely, distinct species to one name. A third difficulty arises from their dilequescent nature, which renders it practically quite impossible to preserve them in such condition as to be available for reference and comparison; and it is equally unsatisfactory sending them through post to other botanists for their opinion. Hence there is in this department, perhaps, more room for error and more difficulty in detecting it, than in any other; and long residence in a district, and not merely an occasional visit or two, would be necessary before anything like an exhaustive list of its species could possibly be arrived at.

Other calls, though happily not of an unpleasant kind, again in 1884 curtailed my visit, so that I would ask the Academy to be good enough to look on this only as a first instalment.

I hope at an early date to make considerable additions to the catalogue presented herewith. I am painfully conscious of the extreme imperfection of this report, and can only trust that the members, considering the exceptional difficulties of the task, will extend to me exceptional indulgence.

Eighty-two species are recorded from Glengariff, where the woods and other most prolific localities for fungi are much less extensive and varied than at Killarney, but unquestionably a very great many more remain for future explorations. Killarney yielded in all one hundred and fifty-six, of which about thirty-five are common to both districts, thus making about two hundred species as the result of my visits. The most noteworthy features are the extraordinary number and variety of two allied genera of Agaricini—Lactarius at Killarney, and Russula at Glengariff. They are very natural and well-marked as genera, and as usually occurs when the large group is easily distinguished, the species are mostly difficult to determine accurately. A Lactarius is immediately recognized by the copious exudation of more or less milky or coloured juice on the slightest wound, but to proceed further, and say what is the species in question, is quite another matter. Russula is quite as easy to recognize, though the written characters are not so explicit. At Glengariff I noticed eight forms of each genus, and at Killarney eleven Lactarii, and three Russulas.

The almost entire absence of Peziza and the Myxogastres in both regions is also remarkable, although I kept a sharp look out for them, especially as the damp and warm climate should be very favourable to their development. The paucity of the various Hyphomycetes and Pyrenomycetes is doubtless due to their being easily passed over in searching for the larger forms, while it was far too late in the season for Æcidia and most of the Puccinieæ. In 1883, at Killarney, I met with some enormous specimens of the beautiful Fly Agaric (A. muscarius), one being 8½ in. in diameter, and its stem 1½ in. thick, while last year every old stump about Muckross Abbey was a mass of A. melleus, which might have been collected by the bushel. It is said to be esculent, but unfortunately not commendable. It is also curious that a careful search over the extensive pasture lands of Muckross failed to elicit a single common mushroom, so abundant everywhere last autumn and for long into the winter, the solitary specimen in the list having been found on Mangerton, and was not the usual field variety. I saw none at either Glengariff or Killarney in 1883.

In 1843 the British Association held its annual meeting in Cork, and in connexion therewith a list of the Fauna and Flora of the district was compiled, the botanical portion by Dr. Power, assisted by Mr. Denis Murray and others. In this list two hundred and seventeen species of fungi are recorded as occurring near Cork, some of which, such as Sclerotium, Rhizomorpha, &c., are now admitted to be only states of other forms. Of the good species about forty-two occur in my list, so far as I can ascertain, but the nomenclature has so much changed of latter years that it is not always easy to identify a species under its old name. Further search would, no doubt, reveal a good many more about Glengariff and Killarney. Combining the two lists together, we have now about two hundred and sixty species recorded from Munster, against five hundred and thirty in Leinster. Rev.

H. W. Lett is preparing a list of what he has found in Ulster, but Connaught is still quite a *terra incognita.*

Annexed is the list *in extenso* of the forms met with, arranged for convenience as in Cooke's *Handbook*—although in some cases that arrangement is now admittedly somewhat obsolete :—

GLENGARIFF.

FAMILY I.—*HYMENOMYCETES.*

ORDER.—AGARINI.

Agaricus. L.

(Amanita)	muscarius, L.
	rubescens, P.
	spissus, Fr.
(Lepiota)	badhami, B. and Br.
(Tricholoma)	cuneifolius, Fr.
	sordidus, Fr.
	subpulverulentus, P.
(Clitocybe)	fumosus, B.
	tumulosus, Kalch.
	gallinaceus, Scp.
	geotrupus, Bull.
	laccatus, Scp.
(Collybia)	radicatus, Reth.
(Mycena)	polygrammus, Bull.
	galericulatus, Scp.
	galopus, Schrad.
	proliferus, Sow.
(Omphalia)	fibula, Bull.
(Hebeloma)	fastigiatus, Fr.
	geophyllus, Sow.
	rimosus, Bull.
	flocculosus, B.
	pyriodorus, P.
	longicaudus, P.
	fastibilis, Fr.
	hiulcus, Fr.
(Flammula)	lentus, P.
(Naucoria)	pediades, Fr.
	conspersus, Fr.
(Stropharia)	semiglobatus, Btsch.
(Hypholoma)	fascicularis, Huds.
(Psilocybe)	semilanceatus, Fr.
	cernuus, Müll.

Cortinarius. Fr.
pholideus, Fr.
cinnamomeus, Fr.
armeniacus, Fr.
camphoratus, Fr.

Hygrophorus. Fr.
pratensis, Fr.
coccineus, Fr.
conicus, Fr.

Lactarius. Fr.
insulsus, Fr.
pyrogalus, Fr.
deliciosus, Fr.
subdulcis, Fr.
torminosus, Fr.
glyciosmus, Fr.
serifluus, Fr.
mitissimus, Fr.

Russula. Fr.
rosacea, Fr.
sardonia, Fr.
nigricans, Fr.
emetica, Fr.
fragilis, Fr.
furcata, Fr.
heterophylla, Fr.
alutacea, Fr.

Cantharellus. Adans.
cibarius, Fr.

ORDER.—POLYPOREI.

Boletus. Fr.
piperatus, Bull.
calopus, Fr.
scaber, Fr.
pachypus, Fr.

Dædalea. Nees.
unicolor, Fr.

ORDER.—HYDNEI.

Hydnum. L.
repandum, L.

ORDER.—CLAVARIEI.

Clavaria. L.
coralloides, L.
ceranoides, P.
inequalis, Müll.
juncea, Fr.

ORDER.—TREMELLINI.

Tremela. Fr.
mesenterica, Rtz.
albida, Huds.

Exidia. Fr.
glandulosa, Fr.

FAMILY II.—*GASTEROMYCETES.*

ORDER.—TRICHOGASTRES.

Scleroderma. P.
vulgare, Fr.

ORDER.—MYXOGASTRES.

Lycogala. Mich.
epidendrum, Fr.

FAMILY III.—*CONIOMYCETES.*

ORDER.—PUCCINIÆI.

Phragmidium. Lk.
bulbosum, Lk.

Puccinia. P.
vincæ, B.

FAMILY IV.—*ASCOMYCETES.*

ORDER.—ELVELLACEI.

Leotia. Hill.
lubrica, P.

Geoglossum. P.
glutinosum, P.

Bulgaria. Fr.
sarcoides, Fr.

Peziza. L.
stercorea, P.
atrata, P.

Helotium. Fr.
æruginosum, Fr.

Xylaria. Fr.
hypoxylon, Griv.

Hypoxylon. Fr.
concentricum, Griv.

KILLARNEY.

Family I.—*HYMENOMYCETES.*

Order—Agarini.

Agaricus. L.

(Amanita)	muscarius, L.
	spissus, Fr.
	cristatus, Fr.
(Armillaria)	melleus, Vahl.
(Tricholoma)	flavo-brunneus, Fr.
	imbricatus, Fr.
	terreus, Schæf.
	subpulverulentus, P.
	sulphureus, Bull.
	albellus, D.C.
	atrosquamosus, Chev.
	nictitans, Fr.
	ustalis, Fr.
	humilis, Fr.
	columbetta, Fr.
	spermaticus, Fr. ?
	panæolus, Fr. ?
(Clitocybe)	tumulosus, Katch.
	cerussatus, Fr.
	candicans, Fr.
	gallinaceus, Scop.
	infundibiliformis, Schæf.
	fragrans, Sow.
	laccatus, Scop.
(Pleurotus)	lignatilis, P.
	mitis, P.
(Collybia)	radicatus, Relh.
	inolens, Bin.
	dryophilus, Bull.

(Mycena)	purus, P.
	pelianthinus, Fr.
	galericulatus, Scop.
	alcaltinus, Fr.
	vulgaris, P.
	tenerrimus, Bk.
	dissiliens, Fr. ?
	polygrammus, Bull.
	vitilis, Fr.
(Omphalia)	pyxidatus, Bull.
	muralis, Sow.
	umbelliferus, L.
(Entoloma)	helodes, Fr.
(Leptonia)	solstitialis, Fr.
(Nolanea)	pascuus, P.
	æthiops, Fr.
(Pholiota)	squamosus, Mull.
(Hebeloma)	flocculentus, Bull.
	fibrosus, Sow.
	plumosus, Bolt.
	longicaudus, P.
	geophyllus, Sow.
	crustuliniformis, Bull.
	rimosus, Bull.
	mesophæus, B.
	euthelus, Br. Br.
(Galera)	hypnorum, Btsch.
(Psalliota)	campestris, L.
	sylvaticus, L.
(Hypholoma)	fascicularis, Huds.
(Panæolus)	fimiputris, Bull.
Coprinus. Fr.	
	atramentarius, Fr.
Cortinarius, Fr.	
	claricolor, Fr.
	armeniacus, Fr.
Lepista, Sm.	
	personata, Fr.
	nuda, Bull.
Paxillus. Fr.	
	involutus, Fr.
Hygrophorus. Fr.	
	pratensis, Fr.
	virgineus, Fr.
	houghtoni, Fr.

Hygrophorus, Fr.

calytræformis, Br. Br.
ovinus, Fr.
lætus, Fr.
coccineus, Fr.
miniatus, Fr.
conicus, Fr.
psittacinus, Fr.
ceraceus, Fr.

Lactarius. Fr.

insulsus, Fr.
pallidus, Fr.
blennius, Fr.
vellereus, Fr.
deliciosus, Fr.
volemum, Fr.
subdulcis, Fr.
torminosus, Fr.
mitissimus, Fr.
turpis, Fr.
quietus, Fr.

Russula. Fr.

virescens, Fr.
emetica, Fr.
ochroleuca, Fr. (?)

Cantharellus. Ad.

cibarius, Fr.

Marasmius. Fr.

urens, Fr.
rotula, Fr.

ORDER.—POLYPOREI.

Boletus. Fr.

luteus, L.
elegans, Schum.
piperatus, Bull.
flavus, With.
laricinus, B.
satanas, Lz.
scaber, Fr.

Polyporus. Fr.

perennis, Fr.
betulinus, Fr.
ferruginosus, Fr.
vaporarius, Fr.

Dædalea. Fr.

unicolor, Fr.

ORDER.—HYDNEI.

Hydnum. L.

repandum, L.
farinaceum, P.

ORDER.—AURICULARINI.

Stereum. Fr.

hirsutum, Fr.

Corticium. Fr.

quercinum, P.

ORDER.—CLAVARIEI.

Clavaria. L.

cristata, Holmsh.
inequalis, Müll.
coralloides, L.
fastigiata, D.C.
stricta, P.
fragilis, Holms.

ORDER.—TREMELLINI.

Tremela. Fr.

tremella, Fr.
mesenterica, Rtz.
albida, Huds.

Exidia. Fr.

recisa, Fr.
glandulosa, Fr.

FAMILY II.—*GASTEROMYCETES*.

ORDER.—TRICHOGASTRES.

Bovista. Dill.

nigrescens, P.

Lycoperdon. Tour.

cælatum, Fr.
saccatum, Vahl.
geminatum, Fr.

Scleroderma. P.

bovista, Fr.

Family III.—*CONIOMYCETES.*

Order.—Sphæronemei.

Asteroma. D.C.
rosæ, D.C.

Order.—Pucciniæi.

Phragmidium. Lk.
bulbosum, Schl.

Triphragmium. Lk.
ulmariæ, Lk.

Puccinia. P.
graminis, P.
striola, Lk.
violarum, Lk.
fabæ, Lk.

Order.—Cœomacei.

Coleosporium. Lev.
tussilaginis? Lev.
sonchi arvensis, Lev.

Melampsora. Cast.
betulina, Desm.
euphorbiæ, Cast.

Cystopus. De By.
candidus, Lev.

Family.—*HYPHOMYCETES.*

Order.—Isariacii.

Ceratium. Ass.
hydnoides, Ass.

Order.—Sepedoniei.

Sepedonium. Lk.
roseum, Fr.

Family.—*ASCOMYCETES.*

Order.—Perisporiacei.

Microsphæria. Lev.
grossulariæ, Lev.

Erysiphe. Hedw.
martii, Lk.

ORDER.—ELVELLACEI.

Helvella. Linn.
crispa, Fr.

Leotia. Hill.
lubrica, P.

Geoglossum. P.
glutinosum, P.

Peziza. L.
aurantia, Fr.
scutellata, L.

Helotium.
æruginosum, Fr.
citrinum, Fr.

ORDER.—PHACIDIACEI.

Rhytisma. Fr.
acerinum, Fr.
salicinum, Fr.

Stegia. Fr.
ilicis, Fr.

ORDER.—SPHÆRIACEI.

Nectria. Fr.
cinnabarina, Fr.

Xylaria. Fr.
hypoxylon.

Hypoxylon. Fr.
species ?

Claviceps.
microcephala, Tul.

XXIV.—On Vetulina stalactites (O. S.) and the Skeleton of the Anomocladina By W. J. Sollas, M.A., D.Sc., Professor of Geology, &c., Trinity College, Dublin. (Plates III. and IV.)

[Read, February 23, 1885.]

The Anomocladina, one of the four families of Lithistid sponges, established by Zittel,[1] is a small and compact group, presenting several characters of considerable interest. With a wide range in time, it is poor in genera and species, and in its present distribution confined to a single locality. Thus it first occurs in the Silurian system, three genera having been described from beds of Wenlock age in Europe and North America; it is represented by three or four genera in the Jurassic, one of these ranging into the Neocomian, and it survives at the present day in a single genus, with a single species, *Vetulina stalactites*, which was first made known to us by Oscar Schmidt,[2] from specimens obtained by the "Hassler" expedition, at a depth of one hundred fathoms, off Barbadoes. The "Challenger" expedition, though it brought home several Lithistids from various localities widely distant from each other, did not obtain any specimens of this family. A much earlier found example than those described by Oscar Schmidt, however, exists in the Bristol Museum, where I found it without a label, side by side with *Dactylocalyx pumiceus*, Stutchbury; and I have little doubt that it was placed there by Stutchbury himself, who probably obtained it along with Dactylocalyx, as dredging in one hundred fathoms was unknown in Stutchbury's time. It is probable that the Bristol specimen, which is much larger and finer than that figured by Schmidt, was obtained from shallow water, *i.e.* not deeper than the Coralline zone. I was in the midst of preparing illustrations for an account of this specimen, which I had recognized as a recent Anomocladina, when Schmidt's work appeared, and as my method of studying Lithistid sponges were not then sufficiently advanced to enable me to supplement Schmidt's observations, I gave up all idea of publishing on the subject. Since then my attention has been recalled to it, partly owing to the appearance of an important Paper by Zittel,[3] throwing doubts on his previous statements, and indeed recalling them, and partly owing to my having devised better methods for studying the Lithistids, so that I can now describe the skeleton of Vetulina with greater accuracy, and in greater detail, than has hitherto been possible.

In Zittel's first account of the Anomocladina we find them defined

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[1] Zittel; Studien ü. fossile Spongien, II. abth. Lithistidæ, 1878.

[2] O. Schmidt; Die Spongien des Meerbusen, von Mexico, 1879.

[3] Zittel; ü. Astylospongidæ und Anomocladina. J. B. Mineral, 1884, II., p. 75. Translated by W. S. Dallas, Ann. N. H. (5) xiv. pp. 271–276.

as distinguished by their "unregelmässig ästige Skeletkorperchen, deren Aeste in einem knotig verdicktem Centrum zusammenstossen. Da dieselben an ihren Enden nur mässig verzweigt sind, so ensteht ein maschiges Netzwerk, das in manchen Fällen grosse Aehnlichkeit mit dem Gittirgerüst gewisser Hexactinelliden erhält," &c. (*loc. cit.* i., p. 23). In effect Zittel considered the skeleton as consisting of corpuscles, each having a solid centrum, with a variable number of rays proceeding from it. These rays unite at their ends with those of neighbouring corpuscles, to form a network deceptively like that of some Dictyonine Hexactinellids. Thus Zittel at this time recognized two kinds of nodes in the network—one furnished by the centrum of the corpuscle, and the other by the union of the rays.

Schmidt, in describing Vetulina, gives substantially the same account, only adding the important statement that "the centrum of each corpuscle grows not only by the superposition of new layers, but also by the more or less intimate additions to it of branches from neighbouring centres, whereto a quantity of shorter curled or knobby excrescences are associated."

Zittel in his latest account finds only one kind of node in the network, and recognizing in it a union of corpuscular rays, concludes that the other kind of node furnished by the centrum is absent, and so is led to regard the elements of the skeleton as simple rods forked at the ends, *i.e.* as the rays of his previously described corpuscles without a centrum. He thus re-defines the characters of the family as follows:—"Skeletal elements, consisting of simple, generally straight, but sometimes curved rods, more or less strongly branched at the two extremities. The branched ends of several (4–9) neighbouring rods meet together, and by their amalgamation form the nodes" (*loc. cit.* ii., p. 276).

In re-examining this question we may most conveniently commence with an inquiry as to the true form of the skeletal corpuscles: Are they centra with rays, or rods merely? To determine this with certainty, it is best to boil a fragment of the sponge skeleton for some hours with a strong solution of caustic potash. This dissolves the opal of which the corpuscles consist; and as it acts with most effect along the surfaces of contact or union between the corpuscles, it is possible, by carefully watching the progress of solution, and arresting it at the right point, to completely separate the corpuscles from one another without damage to them by corrosion. As thus separated, they are very beautiful objects—far more so than from an examination of broken fragments of the skeleton one would expect.

Amidst great diversity of form they constantly maintain a multiradiate character, and are never simple rods. For convenience of description they may be roughly sorted into three groups—which we call types—1, 2, and 3. Type 1 is the staple corpuscle forming the chief mass of the skeleton; it presents a rounded centrum, from which two to five, more or less, cylindrical rays proceed; these are given off from the lower half, or two-thirds of the centrum; they are seldom

branched and terminate in expanded ends, which frequently present an almost absurd resemblance to a foot or boot; the margin of this terminal part is frequently extended into a lamellar expansion or foliation. Though usually smooth, or sparsely spined, the rays may sometimes be richly tuberculated. The remaining upper part of the centrum sprouts out into a profusion of spines, which by branching, and emitting twig-like smaller spines, with rounded ends, give to the head of the corpuscle a characteristic shrub-like appearance. The body of the centrum may also bear tubercles and short, simple spines, though sometimes it remains smooth.

When by prolonged boiling in potash the ends of the rays have been dissolved to sharpened points, and the corpuscle has, in other respects, become simplified, it presents a striking resemblance to the spicules of Holasterella, a fossil sponge of the carboniferous limestone, described by Carter.

The second kind of spicule (type 2) is devoid of the antler-like spines, and possesses a larger number of rays (from six to eight); whence we may conclude that the spines just mentioned represent stunted rays. The rays may be smooth, but are more usually covered with short spines having rounded ends.

The third kind of corpuscle differs more considerably from the type spicule: the centrum loses its somewhat spherical form, and flattens out into a plate, which extends at the margin into rays flattened in the same plane as itself. These rays are shorter, often more irregular, and less clearly defined from the centrum than in the other kinds of corpuscles. Sometimes one or more rays are given off at right angles to the surface of the centrum, which, together with the rays, is usually richly ornamented with rounded tubercles.

Within the centrum, placed more or less excentrically, is an oval, finely granular space, one of the granules with a spherical contour being much larger than the rest, and the whole presenting a striking resemblance to the nucleus of a cell with its nucleolus: as such, or at least as part of a cell, it is, indeed, regarded by Schmidt. That it is an indication of a cell I think very probable, but not that it is actually a nucleus. In the first place it is completely enclosed in the siliceous centrum, having no communication with the exterior. The axes of the rays have also a granular character, but are not so densely crowded with granules as the oval space. The granules of the rays extend into the centrum, and are arranged within it in curves more or less concentric with the oval space, without, however, coming into direct connexion with it: on the contrary, the substance bordering this is always clear and homogeneous, like glass.

Observed with oblique light, the granules which, with transmitted light, are dark-brown in colour, or even black, present a white and glistening appearance, strongly suggestive of air cavities. That they are such is, I think, shown by the fact that when on boiling with potash the solvent gains access to these spaces, they soon become hollowed out, and an oval cavity replaces the granular ellipsoid.

Similarly the granular axes of the rays are more readily dissolved than the periphery.

It appears probable from these observations that a cell is associated with the young spicule, and that the nucleus with its nucleolus, both large like the corresponding structures in a Geodia globule, become inclosed in the substance of the centrum, as this continues its growth; subsequently silica is irregularly deposited within the nucleus, which, decaying away, leaves a number of empty spaces then recognizable as air cavities or granules. So, too, in the axis of the rays, a substance like that which forms the axis of a spicule is deposited, but in a more irregular manner, and this, disappearing after a time, leaves the granulations, or air-spaces, to represent it.

Schmidt could not find the oval granular space in young corpuscles, and as this seemed to me to require explanation, I wished to obtain material for investigation. Having used up the small morsel of Vetulina I had obtained when Curator of the Bristol Museum, I applied to the Honorary Secretary, Mr. S. H. Swayne, expressing a desire to obtain a further supply, and I now take this opportunity of acknowledging the ready kindness with which he responded to my wishes. I boiled the specimen thus obtained in nitric acid, and as it presented a large unbroken surface, I expected to obtain a large crop of young corpuscles: the result, however, was disappointing—not more than half a dozen young forms were secured. These, however, differ markedly from the adult forms, and no less from the representation which Schmidt gives of his youngest stages. The youngest form found is shown in fig. 2, plate IV. Like all the other early forms, it consists of a flat plate, from which a number of arms radiate; both arms and disc possess the corroded appearance so characteristic of young Lithistid corpuscles. In the centre is a clear round space, and within this an excentric round body. In other examples I found the flat body of the corpuscle completely perforated by an oval space, showing that the silicification which had produced the rest of the corpuscle had been arrested in the centre over a definitely limited area. As this is precisely similar to what takes place in a Geodia globule, the hilum there representing the space occupied by the nucleus of the spicule-cell, it seems fair to conclude that a nucleus does exist in connexion with the young corpuscles of Vetulina, but subsequently disappears, as it does in the Geodia globule; only in the case of Vetulina the cavity representing the hilum becomes subsequently completely enclosed within the body of the corpuscle.

Having satisfied ourselves as to the true form of the corpuscles of Vetulina, we may next inquire as to the manner in which they are united together—for this, a special method of examination now to be explained, is necessary. In the first place it is to be observed that when the opal of which a Lithistid corpuscle chiefly consists is dissolved by caustic potash there still remains a residue insoluble in potash. Of its chemical nature I am at present ignorant. It remains as a very tender, delicate film, readily soluble in dilute

acids, not destroyed by ignition, nor to any appreciable extent charred: it is transparent and colourless, and easily stained by eosin. The effect of ignition upon a siliceous spicule, or corpuscle, after it has been boiled in potash, is very singular; it no longer violently decrepitates when heat is applied, but entirely changes its optical characters; its transparency and glassy appearance vanish; it becomes nearly opaque, or rather translucent; appears white and opaline by reflected light, and granular and yellowish-brown by transmitted light. The beauty of the corpuscle is in no way affected by its transformation: seen by reflected light, it makes a good "shew" object.

It is the film which remains after partial solution of a corpuscle which is of importance to us now; for though of scarcely any substance, and tender to the last degree, it is still sufficient to hold the corpuscles together, and still retains the form of those parts of the corpuscles from which the silica has been removed—parts to us of critical interest, since they are those concerned in the union of the corpuscles. The skeleton, after boiling in potash, is transferred to distilled water, and all traces of alkali removed; it is next placed in magenta, which stains the residual membrane, and then left to soak in melted gelatine jelly. It thus becomes prepared for cutting in the freezing microtome, according to the method already described by me.[4] Paraffin would of course be preferable as a medium for embedding were its use here practicable; but owing to the mixture of very hard and very soft parts, and the discontinuity of the slice when cut, one has no choice, and must have recourse to the gelatine freezing process. The slices of jelly containing the cut skeletal network may be dehydrated, and mounted in balsam, or at once put up in glycerine. It is best to mount in both ways: the spicules show better in balsam; the connecting film in glycerine. Slices so prepared reveal the structure of the skeleton beyond all doubt. It consists of a network of which the nodes are mainly of one kind, though produced not by the union of the ends of rods or rays, but chiefly by the centra of the corpuscles. The ends of the rays abut upon these centra, and by means of their foliaceous expansions actually embrace them, so that an exceedingly dense and resistant skeleton results. The two kinds of nodes exist, but are confused or coincident.

Frequently one observes in a section places where a centrum has been torn away; and then the expanded ends of the rays can be seen remaining in their original position, side by side, so as to form a kind of cup, within which the centrum, now torn away, originally lay grasped.

The centrum, as it frequently emits rays from only one part (first kind of corpuscle), receives rays only on the other; and about the place of union the shrub-like growth of spines occurs, concealing,

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[4] Sollas. Q. Jour. Micr. Sci., N. S., xxiv., p. 163.

except in good preparations, the true nature of the node. This sort of union leads to a regular disposition of the corpuscles in successive series, the spined heads, layer after layer, pointing in one direction, and the rayed ends in the other.

As a piece of engineering this construction is perfect: nothing could be better adapted to resist pressure in a given direction; the successive corpuscles are superposed like so many arches, with the solid centrum as a key-stone, and as a place of abutment for the bases of the arches which succeed. The strength of the network is to be measured by the strength of the rays to resist pressure in the direction of their length; no better disposition of them could be made than this, and the result is a skeleton far more resistant than that of any other Lithistid. No other Lithistid that I am acquainted with can withstand strong pressure between the fingers, but no pressure that I can bring to bear in this way causes the least sign of yielding in the skeleton of Vetulina.

Although the mode of union described is the prevailing one, it is not exclusive. Sometimes a ray terminates by abutting on the base of a spine, and sometimes by clasping the side of a neighbouring ray. The flattened corpuscles (type 3) seem never to serve as abutments for the rays of other corpuscles, but are always united to others, clasping them at any point indifferently, though the rays more usually offer them *points d'appui* than the centra.

Since no spines which seem to mark points of union are present in the second kind of corpuscles, and additional rays are, we may conjecture that these unite with the typical corpuscles in the typical manner, but that they do not receive any rays in return themselves. Both the second and third kind of corpuscles may be looked upon as supplemental, putting in an appearance where a gap requires to be filled up. The third kind may be not only supplemental, but subsequent growths arising after the general completion of the network, and thus comparable to the secondary spicules, which appear as an aftergrowth in the network of some Dictyonine Hexactinellids.

The essential characters of the skeleton of Vetulina are obviously present in the fossil Anomocladina. They are to be recognised in Zittel's representations of the Anomocladina structure, as presented in sections, and by isolated corpuscles; and in sections of actual specimens of fossil sponges of this group they are still more unmistakable, if possible. I owe to the kindness of Colonel H. C. Grant a valuable collection of Astylospongidæ, and in the slices from these, which I have had prepared by Mr. Cuttell, all the essential features of the Vetulina skeleton are visible. Of course there are differences: the corpuscles of those Silurian species which I have examined are relatively larger; the spined heads are replaced by thickened stumps, from which only a few spinelets proceed, and the place of abutment is rather upon these stumps, which appear like an elongation of the centrum, than immediately upon the middle of the centra. The mode of arrangement is, however, the same; the spined heads point to the

exterior of the sponge, and the corpuscles succeed one another in a series of arches, as described in Vetulina.

Professor Zittel differed from Professor Martin as to whether the node of the Anomocladina was hollow or solid, Zittel maintaining that it was solid. What has been said as to the presence of a noval granular space within the centrum of Vetulina bears directly on this point, for during life this appears to be less solid than the rest of the corpuscle, and after death, as solution proceeded, it would become a hollow cavity, as in the case of Vetulina treated with caustic potash. In accordance with this I find hollow centra in the skeleton of Astylospongidæ.

It now only remains to redefine the characters of the family: as amended, they run as follows:—

Anomocladina.

Skeletal corpuscles, consisting of a massive centrum, from which a variable number of rod-like rays proceed. The rays terminate in expanded ends, which embrace the centra of neighbouring corpuscles, and so produce a firm network. The outer face of the centrum seldom gives rise to rays, but may be provided with spines; it receives the expanded ends of the articulating rays.

DESCRIPTION OF PLATES III. and IV.

Plate III.

Fig. 1.—A specimen of *Vetulina stalactites*, O. S., preserved in the Bristol Museum. Seen from above; a little less than half the natural size.

Fig. 2.—*Idem*; seen from the other side.

Plate IV.

Fig. 1.—Simple cylindrical spicule of *Vetulina stalactites*.

Figs. 2, 3, 4.—Young forms of skeletal corpuscle.

Figs. 5, 6, 12.—Various forms of fully-formed skeletal corpuscles. Figs. 5 to 8 represent the common or staple form of corpuscle, with spined heads and rays restricted to one side. Fig. 10.—A corpuscle in which the branched spines are replaced by articulating rays. Figs. 11 and 12.—Irregular corpuscles, probably aftergrowths. Fig. 12 shows the mode of articulation of one of these corpuscles with the rays of another of the normal kind.

The figures of plate IV. were drawn in outline by the camera lucida, figs. 1 to 4, as seen by a Zeiss D, oc. 3; and figs. 5 to 12 by a Zeiss D, oc. 2.

XXV.—REPORT ON THE FLORA OF BEN BULBEN AND THE ADJOINING MOUNTAIN RANGE IN SLIGO AND LEITRIM, BY RICHARD M. BARRINGTON, M.A., LL.B., F.L.S., and R. P. VOWELL. (Plate V.).

[Read, April 27, 1885.]

IN the year 1882 Mr. Thomas H. Corry visited the Ben Bulben range in Sligo, with the intention of making a botanical survey of the same, having received from the Academy a grant for that purpose. He was accompanied by two friends, Mr. Dickson, and Mr. R. P. Vowell.

In 1883 Mr. Corry again proceeded to Sligo with Mr. Dickson only, but they were both drowned near Goat Island in Lough Gill before they ever reached the mountains. By reason of this sad and unfortunate accident, the examination of the Ben Bulben range was not completed. The *London Catalogue of British Plants* which Mr. Corry brought with him in 1882 was marked, so as to indicate what species were observed, and the heights to which a large number of them ascended and descended on the mountains. From this Catalogue Mr. A. G. More carefully compiled the Paper read in Mr. Corry's name before the Academy, "On the Heights attained by Plants on Ben Bulben,"[1] which Paper is hereafter frequently referred to. Mr. Vowell, who accompanied Corry in 1882, believes that Annaghcoona (1963 feet) was then mistaken for Ben Whisken (1666 feet). The point marked King's Mountain on the Ordnance Map is marked Seafin in the map attached to this Paper, and the hill over Glencar (1273 feet) is called King's Mountain.

The range of mountains in the northern part of the counties Sligo and Leitrim is, perhaps, the most interesting in Ireland for alpine plants. Like Ben Lawers and the Clova district in Scotland, it is constantly referred to as the *habitat* of rare species, and it was comparatively well known to botanists at a time when the other mountain ranges in Ireland had scarcely been examined.

The map accompanying this Paper shows the district which we explored. The boundary line which separates Sligo from Leitrim runs right through it from north to south.

Its best known point is Ben Bulben in Sligo; but the whole range of mountains is so associated and mixed up in the minds of botanists with this mountain, that species which do not grow on Ben Bulben at all have been recorded from it, whereas they should be limited to another portion of the district.

Most of the interesting species grow at a distance not exceeding seven miles from the south of Donegal bay. The sea approaches to within three miles of the cliffs at one spot, therefore maritime varie-

[1] These "Proceedings," *antea*, p. 73.

ties not usually observed on mountains might be looked for. None, however, were noticed on the range, and *Armeria maritima* is absent, a maritime plant well known to occur on mountains, but *Silene maritima*, *Plantago maritima*, and Cochlearia grow in abundance on the cliffs facing the sea—diminishing or absent altogether on the inland portions of the range.

With the exception of portion of Ben Boo mountain, and the central part of the Leitrim range to the east of Glenade, the district we examined was altogether limestone.

The shape of the mountains is remarkable. They do not descend gradually into the valleys, but are surrounded by cliffs varying in height from 30 to 500 feet. These cliffs extend all round the range to the west of Glenade, and it is only in one or two places that the mountain slope is free from this limestone barrier. There are similar cliffs on the mountains south of Kinlough, but all the rare species can be gathered on the range lying to the west of the Glenade valley, though they are not all confined to it. The mean height of the edge of the cliffs may be taken at 1600 feet. They are composed of loose limestone readily detached, and as this affords a poor security either for the hand or foot, they are dangerous to climb. The cliffs are everywhere separated from the fields and valleys below by a steep slope of talus or debris, extending downwards at an angle varying from 40 to 50 degrees. This slope is frequently 500 feet in vertical height (sometimes more), and the cliffs can only be examined in many places by walking along a narrow track made by the sheep, where the talus meets the face of the precipice. Nowhere else in Ireland is there such an extent of similar cliffs. The top of the talus varies from 900 to 1200 feet above the sea level.

The highest points in the district are as follows:—

Truskmore, ...	2113 feet.
Cloughcorragh, ...	2007 ,,
Annacoona, ...	1963 ,,
Ben Bulben, ...	1722 ,,
Arroo Mountain, ...	1712 ,,
Ben Whisken, ...	1666 ,,
Seafin, ...	1527 ,,
King's Mountain, ...	1273 ,,

No rarity was gathered on Ben Boo, 1365 feet, but this hill, together with the range between Manorhamilton and Lough Melvin, is beyond the district examined carefully.

The Ordnance Map does not give the local names of many mountains. This deficiency has been remedied on the map, from information obtained from shepherds and others met with on the hills.

The only lakes of any extent in the district are—

Glenade, ...	216 feet above the sea
Glencar, ...	97 ,, ,,

There are a few small loughs among the mountains to the east of Glenade. We visited Arroo, 1500 feet above the sea level, but it was absolutely barren.

On the way to Ben Bulben a few specimens were gathered in Lough Gill, near Sligo. The various localities were examined as follows:—

FIRST VISIT.

1884.

June 28. River at Sligo and Goat Island, Lough Gill.
" 29. Drumcliff. West and north face of Ben Bulben, and summit.
" 30. Glencar and cliffs to north of lake.
July 1. Glencar cliffs; Octagorea and Annacoona.
" 2. Top of Trusk; cliffs of Annaghmore, Glenade; Thjumpawn, Crumpawn.
" 3. Glenade cliffs; Skehegwore and Largydonnell cliffs (these are comparatively barren).
" 4. Kinlough; Arroo cliffs, and across Arroo mountain to Glenade and Glencar.
" 5. Ben Boo mountain and bog near Manorhamilton.

SECOND VISIT.

" 31. Kinlough.
Aug. 1. Glenade, Crumpawn.
" 2. Arroo cliffs over Kinlough.
" 3. Kinlough to Cashelgarron, along road.
" 4. Cashelgarron to Seafin, Crookawnalook, Lobiermot Cave.
" 5. Base of Ben Bulben, Ben Whisken, Shee, Annacoona, top of Trusk, Annaghmore? Thjumpawn to Kinlough.
" 6. Sandhills north of Bundoran.

Mr. Vowell was alone on the second occasion. In 1882 he accompanied the late Mr. Corry, and the knowledge of the district he then obtained was of much value subsequently.

As the mountains do not exceed 2113 feet, the vertical range for species is small, and as the conditions of the soil are not uniform, the height to which species ascend or descend is often regulated by the commencement of the cliffs, or the termination or beginning of the slope of talus. Unsheltered, bleak summits, are poor in species: within 100 feet of the top of Trusk, the highest point in the range, twenty-three species only were gathered:—

Aira flexuosa.
Carex rigida.
Lycopodium selago.
Juncus squarrosus.
Galium saxatile.
Eriophorum angustifolium.
" vaginatum.
Potentilla tormentilla.
Melampyrum montanum.
Orchis maculata.

Vaccinium myrtillus.	Anthoxanthum odoratum.
Calluna vulgaris.	Carex binervis.
Lastrea dilatata.	Blechnum spicant.
Empetrum nigrum.	Scirpus cæspitosus.
Luzula sylvatica.	Carex glauca?
,, multiflora.	Euphrasia officinalis.
Solidago virga-aurea.	

The following alpine species and varieties belonging to Watson's "Highland type" were observed. They number twenty-five out of the forty-one known to occur in Ireland, and out of the one hundred and thirteen occurring in Great Britain :—

	Height in ft. B. & V	Corry's height.
Thalictrum alpinum, . .	1950 only.	—
Arabis petræa, . . .	1500–1300	1850?
Draba incana, . . .	1950, highest	1850 to sea level.
,, ,, var. confusa, Ehrh.,	1700 only.	—
Silene acaulis, . . .	1600–1100	1800–1100.
Arenaria ciliata, . . .	1950–1200	1850–1400.
Dryas octopetala, . . .	1220–800	1150.
Epilobium alsinifolium, . .	1200–1000	—
Sedum rhodiola, . . .	1850	1900–1150.
Saxifraga oppositifolia, . .	1600–800	—
,, nivalis, . .	1950 only.	—
,, aizoides, . .	1600–350	1800–600.
Hieracium anglicum, . .	—	1300–600.
,, var. decipiens, Syme.,	—	—
,, var. acutifolium, Back.,	—	—
,, iricum, (specimen poor).	—	1200.
Oxyria reniformis, . .	1950, highest	1200.
Polygonum viviparum, . .	1200 only.	500 (Ben Whisken).
Salix herbacea, . . .	1950–1700	—
Juniperus nana, . . .	1200	1300–1200.
Carex rigida, . . .	2110–1700	1400?
Poa alpina, ...	1900–1500	1850–1700.
Asplenium viride, . . .	1600–700	1850–100.
Aspidium lonchitis, . .	1600–1150	—
Selaginella selaginoides, .	1400–100	1200–200.

Scottish Highland type :—

Rubus saxatilis, . . .	1650, highest	1150.
Circæa alpina, . . .	1200	500.
Saxifraga hypnoides, . .	1300	1850–600.
Crepis paludosa, . . .	1700, highest	
Empetrum nigrum, . .	2100	1900–680.
Listera cordata, . . .	2000, highest	650.
Salix phyllicifolia, . .	1200, about	1200.

	Height in ft. B. & V.	Corry's height.
Highland Intermediate :—		
Galium sylvestre, . . .	350	
Sesleria cærulea, . . .	1100	
British Highland :—		
Chrysoplenium oppositifolium,	1600	1850.
Vaccinium myrtillus, . .	2000	
Cystopteris fragilis, . .	1700	1850–1000.
Lycopodium selago, .	2100–270	1850.
Scottish :—		
Drosera anglica, . . .	400	
Callitriche autumnalis, . .	under 100	
Hieracium pallidum . .	1300 to sea level.	
Habenaria albida, . .		680–300.
Salix pentandra, . . .	400 ?	
Equisetum variegatum, . .	100	
[Alsine verna (Scottish interm.),	not seen.	near top.]
British Scottish :—		
Geum rivale, . . .	1700	1150.
Comarum palustre, . .	350	
Epilobium angustifolium, .	1650–1000	
Myosotis repens, . . .		
Habenaria viridis, . .	400 to sea level.	
Scirpus cæspitosus, . .	2100	
Eriophorum vaginatum, .	2100	1850.
Scottish British :—		
Thalictrum minus, var. montanum	1600 ?	1400–1100.
,, majus, . . .	1300	
Vicia sylvatica, . . .	1350	
Parnassia palustris, . .	1300 to sea level.	1450–200.
Gnaphalium dioicum, . .	1700–400	
Pinguicula vulgaris, . .	1700	1900–1100.
Carex dioica, . . .	1650	
Atlantic British, &c. :—		
Mecanopsis cambrica (At. intermediate), ...	1300	1250–500.
Hypericum androsæmum (At. British), ...		900
Cotyledon umbilicus (At. English),	500, highest	
Pinguicula lusitanica (At. Scottish), ...	400	

	Height in ft. B. & V.	Corry's height.
Lastrea aemula (At. British),	—	950–300.
Adiantum capillus-veneris (Atlantic), ...	700 about.	
Hymenophyllum wilsoni (At. Highland), . . .	1850	

Irish :—

Arenaria ciliata, . . .	1950–1200.	1850–1400.

Cochlearia alpina, 1900–1000 (1200 Corry); *Polygala grandiflora*, 1200-(1175?–900 Corry); *Pyrus rupicola*, 920, and *Melampyrum montanum*, 2100, are not placed under types by Watson.

The following thirty-two species are new to district 9 of the *Cybele Hibernica* :—

†Ranunculus pseudo-fluitans, (R. penicillatus of Corry's List).
Sagina apetala.
Prunus cerasus.
Geum intermedium.
†Rosa arvensis.
Epilobium angustifolium.
,, alsinifolium.
Myriophyllum spicatum.
Œnanthe crocata.
Veronica hederifolia.
Galium sylvestre.
Centaurea cyanus.
†Melampyrum montanum.
Hieracium anglicum—var. acutifolium.
,, murorum.
Hieracium cæsium, var. smithii.
,, pallidum.
Polygonum terrestre.
†Salix alba.
† ,, purpurea.
† ,, smithiana.
† ,, herbacea.
†Taxus baccata.
†Orchis incarnata.
†Listera cordata.
Epipactis latifolia.
Carex paniculata.
† ,, rigida.
,, strigosa.
,, hornschuchiana.
Bromus commutatus.
†Equisetum maximum.

Those marked with an asterisk (†) are recorded in Mr. Corry's List.

The most interesting plant discovered was *Epilobium alsinifolium*, an alpine species not previously found in Ireland. *Alchemilla alpina* is recorded in the *Flora Hibernica* as having been gathered on Ben Bulben, but no botanist has observed it recently, though *A. conjuncta* has been gathered, doubtfully wild, in the vicinity of the mountain. *Lycopodium alpinum* is stated to have been gathered "on the mountains of Sligo" by Mr. J. Wynne, but it was not seen. *Saxifraga nivalis*, which grows nowhere else in Ireland, is confined to one spot, and is now reduced to about thirty plants. *Saxifraga oppositifolia* there is no danger of exterminating. *Poa alpina* occurs on the summit of Annacoona, Ben Bulben, and in a few other places. *Thalictrum alpinum*, though confined to one very limited area, is difficult to

reach. *Draba rupestris*, recorded on the range in Withering, and by Dr. Moore in 1871, was probably *D. incana* (see notes to species). *Adiantum capillus-veneris* is reduced to a few plants in Glencar, and although *Aspidium lonchitis* is still plentiful, the fern-dealers of the district are rapidly diminishing its numbers. *Arabis petræa* is confined to quarter of a mile of cliff in Glenade; and though some specimens grow out of reach, it could be almost exterminated by an expert climber. Mr. Bennett of Croydon has kindly looked over the Potamogetons and Hieracia, and to the Messrs Groves we are indebted for the naming of the Characeæ.

In the following list those species certainly introduced are marked*, those probably introduced ‡, those which appear native, but which are believed to have been introduced at a remote period † :—

Total number of species in the following List, 430.

RANUNCULACEÆ.

Thalictrum alpinum, Linn.—Only on the cliff at Anna Coona, over Gleniff, 1950 feet. Sparingly. Not seen on Ben Bulben.

" *minus*, Linn. var. *montanum*, Wallr. 1600 feet.—North face of Ben Bulben, Annacoona, and cliffs of Glenade; not plentiful anywhere. This is the *T. calcareum* of Jordan.

" *majus*, Sm.—Only at Glenade.

Anemone nemorosa, Linn.—Wood at Glencar, and one or two other places.

Ranunculus psuedo-fluitans, Syme.—In the river at Sligo, and in Glencar lake.

" *hederaceus*, Linn.—Local. In drains about the north end of Glenade and Lough Melvin.

" *flammula*, Linn. 1850 feet.—Common everywhere,

" *acris*, Linn. 1850 feet.—The most abundant of all the Ranunculi.

" " var. *vulgatus*, Jord.—With the petioles and base of the stem thickly covered with fulvous hairs, and the segments of the radical leaves overlapping; it occurs occasionally on the cliffs.

" *repens*, Linn.—Common.

" *bulbosus*, Linn.—Frequent on the talus; not observed elsewhere.

" *ficaria*, Linn.—In sheltered places on Glenade cliffs.

Caltha palustris, Linn. 1050 feet.—Common.

NYMPHAEACEÆ.

Nymphæa alba, Linn.—River at Lough Gill.

Nuphar lutea, Sm.— " " Less frequent than preceding species.

PAPAVERACEÆ.

Meconopsis cambrica, Vig. 1300 feet.—Several specimens in a gully on King's Mountain. Very sparingly on the north side of Ben Bulben.

FUMARIACEÆ.

Fumaria officinalis, (?) Linn.—Specimens gathered in a cultivated field north of Sligo: too imperfect to identify with certainty.

CRUCIFERÆ.

Sinapis arvensis, Linn.—Common in cultivated fields.
,, *alba*, Linn.—Frequent.
Sisymbrium officinale, Scop.—Roadside near Kinlough.
,, *alliaria*, Scop.—Foot of cliffs over Colonel Whyte's Cottage in Glencar.
Cardamine pratensis, Linn. 1600 feet.—Common.
,, *hirsuta*, Linn.—Glenade, &c.; not common.
Cardamine sylvatica, Link.—Common.
Arabis petræa, Lam. 1330 feet.—Very rare. In one place on the cliffs of Glenade there are about fifty plants, some growing in inaccessible places. Corry's height for this species, 1850 feet, would indicate a different locality, but there is a query prefixed to *the species* in his original marked *London Catalogue*.
,, *hirsuta*, Brown.—Common on the cliffs.
Barbarea vulgaris, Brown.—Roadside near Milltown.
Nasturtium officinale, Brown.—Common.
Cochlearia alpina, Watson. 1900 feet.—Frequent on cliffs at a high level. A form with the pods globose, and not distinguishable from *Cochlearia officinalis*, is common.
Draba incana, Linn. 1950 feet.—Common all over the cliffs.
,, var. *confusa*, Ehrh.—This form has stellate hairs on the pods, and it was only gathered at Annacoona, over Gleniff.

Draba rupestris, Brown.—First recorded by Withering as plentiful "on the limestone mountains of Sligo and Leitrim." Subsequently by the late Dr. Moore in the *Journal of Botany* (vol IX., p. 299), as having been gathered on that part of the Ben Bulben range known locally as "King's Mountain," when he was botanizing there in company with Prof. Thisleton Dyer, in the last week in May 1871. Only two small plants were then gathered, one of these is now in the herbarium of Mr. A. G. More; the other I have not been able to trace. A careful but unsuccessful search was made for *D. rupestris*, but we only obtained some dwarf forms of *D. incana*, not unlike *D. rupestris* at first sight. On comparing Mr. More's

specimen with these, doubts were expressed about its being accurately named, and it was then forwarded to Mr. A. Bennett of Croydon, who kindly examined it. He says: "With respect to the Ben Bulben *rupestris*, it is a pity the specimen is so young (gathered in May), but there is a character of *rupestris* it shows under a half inch, *i. e.* 'stigma distinctly notched'" (Syme's *Eng. Bot.*). Babington, in his 8th ed., does not mention this character, nor does Hooker in the *Student's Manual*. Fries says, "*Stylo heri, stigmati subpunctiformi*." Under *incana* he says, "*siliculis saepe tortis*." Everyone seems to mention this character—yet my sheets are conspicuous by its absence. Syme says of *rupestris*, the pods never twisted, and always with stellate pubescence on them; while Dr. Lange says, in *Conspectus Floræ Grœnlandicæ*, "Siliculis minoribus, lanceolatus (glabris stellatis, pilosis)." There is one character of this specimen of *rupestris* I do not like, and that is the rootstock—to my eyes it is much too *incana*-like. On the whole, while I do not like to say it is not *rupestris*, so I cannot say it is *rupestris*. You must search for this form in a later state. I have just looked at Hartman's *Handbook*, *i. Scand. Flora*, and he repeats Lange's observation, "glatta ell hariga," so that there is no certainty about the hairiness of the pod; it may be hairy or not.

Many of the Ben Bulben specimens of *D. incana* have no sign whatever of the pod twisting. The pods of Scotch specimens of *D. rupestris* examined are covered with stellate pubescence, and are a marked contrast to the glabrous pods of the Ben Bulben *D. rupestris*, and even to the pods of *D. confusa*, Ehrh., from the same district. The root-stock of the Ben Bulben plant is so like *D. incana* that the species should not be retained in the Irish List until better specimens are forthcoming.

During the first visit of Messrs. Corry and Dickson to Ben Bulben, dwarf specimens of *D. incana* were collected, which at the time were taken for *D. rupestris*, but the error was corrected by Prof. Babington. The specimen mentioned by Mr. Hind as growing in soil obtained from Ben Bulben (see *Jour. Botany*, vol. IX., p. 325) is not *D. rupestris*, but *D. verna*. This specimen is in the herbarium of Trinity College, Dublin.

Capsella bursa-pastoris, Moench.—Common along roads at a low level.

VIOLACEÆ.

Viola palustris, Linn.—Frequent in bogs.

,, *sylvatica*, Fries. 1700 feet.—Frequent. The form *riviniana*, Reich.

[,, *canina*, Auct.—No specimen was gathered].

DROSERACEÆ.

Drosera rotundifolia, Linn.—Scarce; seen only in one or two bogs on the hills.

Drosera anglica, Huds.—In bog between Manorhamilton and Ben Boo mountain.

Polygalaceæ.

Polygala vulgaris, Linn. 1700 feet.—Frequent.
,, ,, var. *grandiflora*. 1200 feet.—Ben Bulben, and occasionally on the cliffs of other mountains.
,, *depressa*, Wender.—Common. "By far the most common milkwort in Britain."—Syme, *Eng. Bot.*

Caryophyllaceæ.

Silene inflata, Sm.—Not common. On road near Sligo Asylum.
,, *maritima*, With. 1550 feet.—Frequent on the cliffs, and abundant on Ben Bulben.
,, *acaulis*, Linn.—Common on the cliffs north-east of Ben Bulben; abundant on Ben Bulben, forming large green cushions.
Lychnis diurna, Sibth.—Road near Milltown. Plentiful on some cliffs to a high level, about 1800 feet.
,, *flos-cuculi*, Linn.—Common.
Cerastium glomeratum, Thuil.—Roadside near Sligo.
,, *triviale*, Link. 1850 feet.—Common.
Stellaria media, With.—Common.
,, *holostea*, Linn.—Base of Ben Bulben; not common.
,, *graminea*, Linn. 1050 feet.—Frequent.
,, *uliginosa*, Murr. 1050 feet.—Frequent.
Arenaria trinervis, Linn.—One place on cliffs of Glenade.
,, *ciliata*, Linn.—Plentiful at Annacoona to 1950 feet. A few plants on Seafin mountain at 1200 feet, and near Lobiermot Cave, south-east of Ben Bulben, but not seen on Ben Bulben proper.
[*Alsine verna*, Bartling.—In Corry's List, and previously recorded from the county Sligo in *Cyb. Hib.*, but not seen by us.]
Sagina apetala, Linn.—On a wall by the river at Sligo.
,, *procumbens*, Linn.—Common everywhere.
,, *nodosa*, Meyer.—Common about Glenade district.
Spergula arvensis, Linn.—Frequent in cultivated ground.

Portulacaceæ.

Montia fontana, Linn. 900 feet.—Rare; by a mountain stream between Glencar and Trus.

Hypericaceæ.

Hypericum androsæmum, Linn.—Glencar and a few other places.
,, *tetrapterum*, Fries.—Local.
,, *pulchrum*, Linn.—Generally distributed.

LINACEÆ.

Linum cathorticum, Linn.—Common on the talus of the cliffs.

GERANIACEÆ.

Geranium molle, Linn.—Kinlough; scarce.
,, *dissectum*, Linn.—Roadside near Cashelgarron. This species and the preceding do not seem to be nearly so common in some parts of north-western Ireland as on the east coast; whereas the next species, *G. lucidum*, is of more frequent occurrence than on the east coast.
,, *lucidum*, Linn.—Glencar, and near Ben Boo mountain.
,, *robertianum*, Linn. 1700 feet.—Common everywhere.
Oxalis acetosella, Linn. 1600 feet.—Common. Ranges from sea level to 1600 (Corry, 1900).

ILICINEÆ.

Ilex aquifolium, Linn.—Common on Glencar cliffs.

CELASTRACEÆ.

Euonymus europæus, Linn.—Shores of Lough Gill (sea level to 575, Glencar, Corry); 750, Watson's, *Cyb. Brit.*

SAPINDACEÆ.

**Acer pseudo-platanus*, Linn.—Glencar; planted.

LEGUMINIFERÆ.

Ulex europæus, Linn.—Common.
Anthyllis vulneraria, Linn.—Ben Bulben and other cliffs.
Trifolium pratense, Linn. -Common.
,, *repens*, Linn. 1550 feet.—Common.
,, *minus*, Relhan.—Common.
Lotus corniculatus, Linn. 1500 feet.—Common.
,, ,, A fine form, with large yellow flowers, occurs on the cliffs.
Vicia cracca, Linn.—Frequent.
,, *sylvatica*, Linn. 1350 feet.—Cliffs at Glenade and Arroo mountain; in both places growing with *Epilobium augustifolium*.
,, *sepium*, Linn. 1300 feet.—Common.
Lathyrus pratensis, Linn.—Common.

ROSACEÆ.

Prunus spinosa, Linn. 1200 feet.—Frequent.
* ,, *cerasus*, Linn.—Near Kinlough, not far from a garden.

Spiræa ulmaria, Linn. 1700 feet.—Common.

Achemilla vulgaris, Linn. 1850 feet.—Very common on the mountains. The hairy form, var. *montana*, Wild., met with occasionally.

,, *alpina*, Linn. Not seen.—Recorded from Ben Bulben in the *Flora Hibernica*, but only *Achemilla conjuncta* has been gathered in suspicious situations near the foot of the mountain.

Potentilla fragariastrum, Ehrh.—Common.

,, *tormentilla*, Schenk. Top of Trusk, 2113 feet to sea level. —Common.

,, *procumbens*, Sibth.—Common about Glencar (Vowell.)

,, *anserina*, Linn.—Common.

Comarum palustre, Linn.—Only seen in a bog near Drumcliff.

Fragaria vesca, Linn.—Common.

Rubus idæus, Linn. 1400 feet to sea level.—Common, especially between Manorhamilton and Glencar.

,, *saxatilis*, Linn. 1650 feet.—Holes in side of Trusk, Glenade cliffs, and on Arroo mountain, Kinlough.

,, *discolor*, W. and N., and three other forms.

Geum urbanum, Linn.—Occurring frequently on talus.

,, *intermedium*, Ehrh.—On talus of cliffs of Glenade.

,, *rivale*, Linn. 1700 feet.—Very common on the talus of the cliffs. On Ben Bulben and in Glenade a handsome but abnormal form was gathered, looking at a distance like a small red anemone. The stem is short; the inner calyx segments are sometimes enlarged into leaves. The petals are not only double, but number fifteen to twenty, and vary in size.

[Two roots cultivated in a garden have since produced flowers, all of the normal form.—*Note added in Press, June*, 1885.]

Dryas octopetala, Linn. 800 to 1220 feet.—Generally distributed all over the range.

Rosa spinosissima, Linn. 1300 feet. Lough Gill, and occurring frequently on cliffs.

,, *tomentosa*, Sm.—Common in Glencar, and in a few other places.

,, *canina*, Linn.—Common.

,, *arvensis*, Huds.—The commonest rose in Glencar.

Cratægus oxyacantha, Linn. 1200 feet.—Common.

†*Pyrus aria*, Hooker.—Goat Island, Lough Gill.

,, *rupicola*, Syme, E. B.—One tree seen by Vowell on the exposed limestone cliffs over Glencar, 1882.

,, *aucuparia*, Gaert. 1600 feet on cliffs.—Frequent; small stunted trees grow up to 1850 feet in the large sheltered holes so common in parts of this range.

LYTHRACEÆ.

Lythrum salicaria, Linn.—Very common.

ONAGRACEÆ.

Epilobium angustifolium, Linn. 1650 to 1000 feet—In some of the large deep holes which occur on the east side of Truskmore; also on the cliffs of Glenade, under Trusk, and on Arroo mountain, over Kinlough.

,, *hirsutum*, Linn.—Not uncommon along the streams.

,, *parviflorum*, Schreb.—Local.

,, *montanum*, Linn. 1600 feet.—Common.

,, *obscurum*, Schreb.—Common.

,, *palustre*, Linn. 1500 feet.—Not common. In Glenade and other places.

,, *alsinifolium*, Linn. 1000 feet.—Seen only in two places on the Glenade cliffs, both close to each other. In one locality there is a large bed of it, and it is scattered in patches along a small stream. (See *Journal of Botany* for August, 1884.)

Circæa lutetiana, Linn.—Common on the top of talus and elsewhere.

,, *alpina*, Linn.—Glenade, at the foot of the cliffs where the talus begins, and in some places at Arroo mountain.

HALORAGIACEÆ.

Myriophyllum spicatum, Linn.—In Glencar lake and Lough Gill river.

,, *alterniflorum*, D.C.—Glencar lake.

Callitriche platycarpa, Kutz.—On mud by a mountain stream, over Glencar, and elsewhere.

,, *autumnalis*, Linn.—Plentiful in the river at Sligo.

GROSSULARIACEÆ.

**Ribes rubrum*, Linn.—On the cliffs at Glenade. Not in fruit or flower; but as the leaves are glabrous on both sides, it is probably var. *sativum*.

CRASSULACEÆ.

Sedum rhodiola, D.C. 1850 feet.—Abundant on the cliffs.

**Sempervivum tectorum*, Linn.—Planted on the roofs of some houses in Glenade.

Cotyledon umbilicus, Linn.—Occurs sparingly in a good many places, but not seen on the cliffs, nor above 500 feet.

SAXIFRAGACEÆ.

Saxifraga oppositifolia, Linn.—At Glenade, Annacoona, Arroo mountain, &c. Over 1200 feet, but not seen on Ben Bulben.

Saxifraga nivalis, Linn. 1950 feet.—About thirty plants at one place near Annacoona. Not elsewhere.

,, *aizoides*, Linn.—Abundant everywhere through the mountains. 1600 to 350 feet.

,, *hypnoides*, Linn. 1300 feet.—Common on the cliffs.

[*Saxifraga stellaris*.—Not observed. "One of the most widely distributed mountain plants in Ireland. It is singular that it has not been found on Ben Bulben."—*Cyb. Hib.*, p. 117.]

Chrysosplenium oppositifolium, Linn. 1600 feet.—Common.

Parnassia palustris, Linn. 1300 feet to sea level.—Common, and generally distributed.

UMBELLIFERÆ.

Hydrocotyle vulgaris, Linn.—In a bog near Glenade lake, but not at all common.

Sanicula europæa, Linn. 907 feet.—Common.

Apium graveolens, Linn.—Near Drumcliff (Vowell, 1882).

Heliosciadium nodiflorum, Koch.—Frequent.

Bunium flexuosum, With.—Frequent. Corry's highest is 1850 feet, exceeding Watson's Highland limit. We did not see it above the top of the talus, 1200 to 1300 feet.

Œnanthe crocata, Linn.—Rare. At Glencar.

Angelica sylvestris, Linn. 1700 feet. Common.

Heracleum sphondylium, Linn. 1600 feet.—Common.

Daucus carota, Linn.—Near the shore of Glencar lake.

Torilis anthriscus, Gaert.—In a lane near Drumcliff.

Chærophyllum sylvestre, Linn. 1300 feet.—Common in most places.

[*Conium maculatum*, Linn.—Grange; *vide* Corry's MS. List.]

ARALIACEÆ.

Hedera helix, Linn. 1300 feet.—Common on the cliffs.

CAPRIFOLIACEÆ.

Sambucus nigra, Linn.—Near Kinlough, and other places, but not common.

Viburnum opulus, Linn.—Shores of Loughs Gill and Glencar.

Lonicera periclymenum, Linn.—Common.

RUBIACEÆ.

Galium saxatile, Linn. 2100 feet to sea level.—Common.

,, *sylvestre*, Poll.—Rare. Glenade.

,, *palustre*, Linn. Common.

,, *aparine*, Linn.—Common.

Asperula adorata, Linn.—Common about Glencar.

[*Sherardia arvensis*, Linn.—Not seen. This colonist is rare in some of the N.W. counties.]

VALERIANACEÆ.

Valeriana officinalis, Linn.—Frequent.

DIPSACEÆ.

Scabiosa succisa, Linn. 1750 feet.—Very common everywhere.

COMPOSITÆ.

Carduus lanceolatus, Linn. 1400 feet.—Generally distributed.
,, *palustris*, Linn. 1600 feet.—Common.
,, *pratensis*, Huds. 1950 feet.—Common, from the sea level upwards; growing close to *Sax. nivalis* at 1950. Watson's limit is 1200 feet.
,, *arvensis*, Curt.—Common.
Arctium intermedium, Lange. (?)—In a lane near Milltown; specimen too young to identify.
Centaurea nigra, Linn.—Common everywhere.
,, *cyanus*, Linn.—Glenade, in cultivated ground.
†*Chrysanthemum segetum*, Linn.—In cultivated ground about Glenade, Grange, &c.
,, *leucanthemum*, Linn.—Common.
Matricaria inodora, Linn—Not common; near Kinlough.
Achillea millefolium, Linn.—Common.
,, *ptarmica*, Linn.—Generally distributed.
‡*Artemisia vulgaris*, Linn.—Near Kinlough, in waste places. This species generally occurs near houses, &c., in this district, and has, perhaps, been introduced.
Gnaphalium uliginosum, Linn.—Roadside, Glenade and Cashelgarron.
,, *dioicum*, Linn.—Scarce. Annacoona, 1700 feet; a few places at Glenade, 400.
Senecio vulgaris, Linn.—Common.
,, *jacobæa*, Linn.—Common.
,, *aquaticus*, Huds.—Much more plentiful than the preceding.
Bellis perennis, Linn. 1950 feet.—Common.
Solidago virgaurea, Linn. 2100 feet.—Distributed generally over the talus. (Var. *cambrica* in Corry's printed List is due to a clerical error).
Tussilago farfara, Linn. 1700 feet.—Plentiful on the talus at the base of cliffs in many places.
Petasites vulgaris, Desf.—Along roadsides and waste ground, near Miltown and Sligo.
Eupatorium cannabinum, Linn.—Glencar, &c., frequently.
Lapsana communis, Linn.—Not uncommon.
Hypochæris radicata, Linn. 1850 feet. Watson's limit 1740.—Common on the cliffs.
Leontodon autumnalis, Linn.—Common on the cliffs.
Taraxacum officinale, Wigg. 1700 feet.—Generally distributed.

Sonchus oleraceus, Linn.—Generally distributed, more so than the next species.
,, *asper*, Hofm. 907 feet.—Not uncommon.
,, *arvensis*, Linn.—Near Kinlough.
Crepis virens, Linn.—Frequent.
,, *paludosa*, Moench. 1700 feet.—Damp places on the cliffs; common.
Hieracium pilosella, Linn. 1300 feet.—On dry banks; frequent.
,, *anglicum*, Fries.—Common on the cliffs, &c.
,, ,, var. *decipiens*, Syme.—On mud, side of Arroo mountain, over Kinlough.
,, ,, var. *acutifolium*, Back.—Glenade cliffs.
,, ,, *iricum*. (?) Specimen imperfect.
,, *murorum*, Linn.—Ben Bulben and Goat Island, Lough Gill.
,, *cæsium*, Fries.—Ben Bulben and Goat Island, Lough Gill,
,, ,, the var. *smithii*, of Baker.
,, *pallidum*, Fries. Sea level to 1300 feet.—Goat Island, Lough Gill, the Three Bunions, over Glencar, and Arroo mountain, Glenade.
[*Hieracium gibsoni*, Back.—In Corry's List, but there seems to be some doubt about the identification of the specimen.]

CAMPANULACEÆ.

Campanula rotundifolia, Linn. 1300 feet.—Very common on cliffs.

ERICACEÆ.

Vaccinium myrtillus, Linn. 2100 feet.—Common on the mountains.
Erica tetralix, Linn. 1700 feet.—Not so common as the next species.
,, *cinerea*, Linn. 1600 feet.—Common.
Calluna vulgaris, Salisb. 2100 feet.—Abundant.

JASMINACEÆ.

Fraxinus excelsior, Linn. 907 feet.—Glencar.
**Ligustrum vulgare*, Linn.—By the lake at Glencar.

GENTIANACEÆ.

Erythræa centaurium, Pers.—Not common, but occurs here and there.
Menyanthes trifoliata, Linn. 1400 feet.—Plentiful in some places.

CONVOLVULACEÆ.

Convolvulus sepium, Linn.—Roadside, near Drumcliff, &c.

SCROPHULARIACEÆ.

Scrophularia calbisii, Hornem.—Near Drumcliff, &c.

Scrophularia nodosa, Linn.—Not common.
Digitalis purpurea, Linn. 1700 feet.—Common.
**Linaria cymbalaria*, Mill.—Rocks on Goat Island, Lough Gill, and on houses about Sligo.
**Mimulus luteus*, Linn.—One place on shore of Lough Melvin, near Kinlough.
Veronica hederæfolia, Linn.—About Kinlough.
,, *arvensis*, Linn.—Kinlough and Glenade.
,, *serpyllifolia*, Linn.—Common.
,, *officinalis*, Linn. 1600 feet.—Common.
,, *chamædrys*, Linn.—Common.
,, *scutellata*, Linn.—Not common; in a bog on mountains near Trusk, and in Glenade.
,, *anagallis*, Linn.—Near Miltown.
,, *beccabunga*, Linn. 950.—Common.
Euphrasia officinalis, Linn. 2000 feet to sea level.—Abundant on the talus.
Bartsia odontites, Huds.—Local; near Miltown.
Pedicularis palustris, Linn. 1050 feet.—Frequent.
,, *sylvatica*, Linn. 1700 feet.—Plentiful.
Rhinanthus crista-galli, Linn.—Common. A large branched form was observed approaching var. *major*.
Melampyrum pratense, Linn.—Near Ben Whisken, &c.
,, var. *montanum*. 2100 feet.—generally distributed over the mountains.

LABIATÆ.

Mentha hirsuta, Linn.—Near Drumcliff and other places.
Thymus serpyllum, Fries. 1700 feet.—Abundant on the cliffs.
[*Nepeta glechoma*, Benth.—Apparently wanting.]
Prunella vulgaris, Linn. 1700 feet.—Common.
Stachys palustris, Linn—Common.
,, *sylvatica*, Linn.—Roadside, near Drumcliff.
Galeopsis tetrahit, Linn.—Common in cultivated ground.
[*Lamium amplexicaule*, Linn.—Cliffony, *fide* Corry's MS. Catalogue.]
,, *intermedium*, Fries.—Rare; near Kinlough.
,, *purpureum*, Linn.—Frequent.
Ajuga reptans, Linn.—Frequent; abundant in the wood at Glencar.
[*Teucrium scorodonia*, Linn.—Not seen.]

BORAGINACEÆ.

Myosotis cæspitosa, Schultz.—Frequent; more often met with than *arvensis*.
,, *palustris*, With.—Near Drumcliff.
,, *arvensis*, Hoffm.—Rather scarce.
,, *versicolor*, Reich.—Common,
**Symphytum officinale*, Linn.—Near houses; probably an escape.

Pinguiculaceæ.

Pinguicula vulgaris, Linn. 1700 feet.—Common.
,, *lusitanica*, Linn.—In a bog near Manorhamilton.

Primulaceæ.

Primula vulgaris, Huds. 1600 feet.—Common, everywhere.
Lysimachia vulgaris, Linn.—Frequent.
,, *nemorum*, Linn. 1100 feet.—Common.
Anagallis tenella, Linn.—Common in bogs.
Samolus valerandi, Linn.—Frequent.

Plantaginaceæ.

Plantago major, Linn.—Frequent.
,, *lanceolata*, Linn.—Common.
,, *maritima*, Linn. 1200 feet.—Plentiful on many of the cliffs.
Littorella lacustris, Linn.—Shores of Glenade lake and Lough Gill.

Chenopodiaceæ.

Chenopodium album, Linn.—Common in fields.
,, *bonus henricus*, Linn.—Kinlough.

Polygonaceæ.

Rumex conglomeratus, (?) Murr.—Specimens too young to identify with certainty.
,, *nemorosus*, Schrad.—Frequent.
,, *obtusifolius*, Auct.—Common.
,, *crispus*, Linn.—Common.
,, *acetosa*, Linn.—Common on mountains.
,, *acetosella*, Linn. 1800 feet.—Common on mountains.
Oxyria reniformis, Hooker. 1950 feet to 1200.—Most frequent on the north face of Ben Bulben, but it also occurs at Annacoona, Ben Whisken, &c.
Polygonum aviculare, Linn.—Frequent.
,, *hydropiper*, Linn.—Near Kinlough, &c.
,, *persicaria*, Linn.—Near Kinlough, &c.
,, *amphibium* Linn. var. *terrestre*.—Met with in several places.
,, *viviparum*, Linn.—Very local. Seen on the north face of Ben Bulben only, but gathered on talus of Ben Whisken in 1882 by Messrs. Dickson and Corry.
* ,, *fagopyrum*, Linn.—Field near Kinlough.

Empetraceæ.

Empetrum nigrum, Linn. 2100 to 1200 feet.—Common on the hills.

EUPHORBIACEÆ.

Euphorbia helioscopia, Linn.—Local. Near Cashelgarron.
 ,, *peplus*, Linn.—Local. Near Cashelgarron.

URTICACEÆ.

Parietaria diffusa, Koch.—On walls, &c., Sligo Bridge.
Urtica dioica, Linn. 1200 feet.—Abundant at foot of cliffs in some places.
 ,, *urens*, Linn.—Kinlough.

AMENTIFERÆ.

Quercus robur, Linn.—Cliffs of Glenade.
Corylus avellana, Linn. 1200 feet.—Common.
Alnus glutinosa, Linn.—Common.
Betula alba, Linn. var. *verrucosa*, Ehrh.—In Glencar, &c.; var. *glutinosa*, Fries. (pubescent form), on the cliffs in Glenade.
Myrica gale, Linn.—Glenade, Ben Boo mountain, and other places.
**Salix pentandra*, Linn.—About Grange and Kinlough, planted.
* ,, *alba*, Linn.—Grange. Co. Sligo, Vowell.
* ,, *purpurea*, Linn.—Between Glencar and Ben Boo mountain.
* ,, *viminalis*, Linn.—Near Ben Boo mountain, &c., planted.
[,, *smithiana*, Willd.—In Corry's List at Grange.]
 ,, *cinerea*, Linn.—Frequent. Grange, &c.
 ,, *aurita*, Linn.—Common, from sea level to 2100 feet on top of Trusk.
 ,, *capræa*, Linn.—On Glenade cliffs under Trusk, sparingly, about 1400 feet.
 ,, *phylicifolia*, Linn.—On the north face of Ben Bulben—not over 1400 feet—and near Kinlough, Co. Leitrim; height seldom exceeding two feet.
 ,, *herbacea*, Linn. 1950–1700 feet.—On Ben Bulben and at Annacoona. Not seen under 1700 feet.

CONIFERÆ.

Juniperus nana, Willd.—Cliff over Glencar at 1200 feet; very well marked. On the cliffs at Ben Bulben a form less easily distinguished from *J. communis* was observed.
Taxus baccata, Linn.—Rare. Cliffs over Colonel Whyte's Cottage, Glencar, at 900 feet.

TYPHACEÆ.

Sparganium ramosum, Huds.—Glenade.

ARACEÆ.

Arum maculatum, Linn.—Woods at Glencar, &c.

Lemnaceæ.

Lemna trisulca, Linn.—In the river near Sligo.

Naiadaceæ.

Potamogeton natans, Linn.—In the river near Sligo.
,, *polygonifolius*, Pour. 1500 feet.—Bogs on mountains, &c. Not common.
[,, *rufescens*, Schrad.—In Corry's List, and marked in his *London Catalogue* as found in the river at Sligo, but not seen there by us. Corry omits *P. zizii*, which is abundant in the same locality.]
,, *heterophyllus*, Schreb.—Glenade lake.
,, *pusillus*, Linn.—Glenade lake.
,, *flabellatus*, Bab.—Glencar lake.
,, *zizii*, Mertens and Koch.—In the river at Sligo, and Glenade lake. Named by Mr. Arthur Bennett, who observes—"The Lough Gill plant represents one form, and the Glenade plant another. neither being the typical plant of Mertens and Koch."

Alismaceæ.

Triglochin palustre, Linn. 1100 feet.—Common.
Sagittaria sagitifolia, Linn.—Young state, with submerged linear pellucid leaves, in the river at Sligo.
Alisma plantago, Linn.—Shore of Lough Gill, near Sligo.
,, *ranunculoides*, Linn.—Shore of Lough Gill, near Sligo.

Hydrocharidaceæ.

**Elodea canadensis*, Wick.—Lough Gill river.

Orchidaceæ.

Orchis mascula, Linn.—Not common.
,, *incarnata*, Linn.—Glenade, sparingly.
,, *maculata*, Linn. 2100.—Very common everywhere, from the sea level to the top of Trusk.
Gymnadenia conopsea, Brown.—Glencar. In many places, but not a common plant.
Habenaria albida, Rich.—Base of Ben Whisken very sparingly, and on talus of King's Mountain; common in one place.
,, *viridis*, Brown.—Glenade, Goat Island, and Lough Gill, &c.; frequent.
,, *bifolia*, Bab.—Nowhere plentiful, but met with in nearly every part of the district.
,, *chlorantha*, Bab.—Common.
Listera cordata, Brown. 2000 feet.—Frequent on the mountains.
,, *ovata*, Brown.—Common.
Epipactis latifolia, Auct.—Shore of Lough Gill, near Sligo.

IRIDACEÆ.

Iris pseudacorus, Linn. 1100 feet.—Common.

LILIACEÆ.

Scilla nutans, Sm. 1350 feet.—Common about Glencar, and met with frequently in the mountains.
Allium ursinum, Linn. 1050 feet.—Glencar wood.
Narthecium ossifragum, Huds. 1700.—Common in bogs on hills.

JUNCACEÆ.

Luzula sylvatica, Beck. 2100 feet.—Common everywhere.
,, *multiflora*, Koch. 2100 feet.—Common.
[,, *pilosa*, Willd.—In Corry's List; not seen.]
Juncus conglomeratus, Linn. 1850 feet.—Frequent.
,, *glaucus*, Sibth.—Frequent.
,, *effusus*, Linn. —Common.
,, *acutiflorus*, Ehrh.—Common.
,, *supinus*, Moench.—Common.
,, *bufonius*, Linn.—Frequent.
,, *squarrosus*, Linn. 2100 feet.—Very common on the mountains.

CYPERACEÆ.

Schœnus nigricans, Linn.—Base of Ben Bulben and Seafin.
[*Blysmus rufus*, Link.—Marked in Corry's *Lond. Cat.* at mouth of Drumcliff river. Locality not visited by us.]
Scirpus palustris, Linn.—Frequent.
,, *pauciflorus*, Lightf.—Near the margin of the lakes at Glencar and Glenade.
,, *cæspitosus*, Linn. 2000 feet.—Common.
,, *setaceus*, Linn.—Frequent.
,, *lacustris*, Linn.—Common by the lakes.
Eriophorum vaginatum, Linn. 2100 feet—Frequent on mountains.
,, *angustifolium*, Roth. 2100 feet.—Common.
Carex dioica, Linn. 1650 feet.—Rare; only seen on Trusk.
,, *pulicaris*, Linn.—Common, especially on talus of cliffs.
,, *paniculata*, Linn.—Rare. Bog by the roadside, between Ben Boo and Manorhamilton.
[,, *vulpina*, Linn.—In Corry's List, probably gathered near the sea-shore.]
,, *stellulata*, Good.—Very common.
,, *remota*, Linn.—Frequent in Glenade.
,, *ovalis*, Good.—Common.
,, *stricta*, Good.—Specimens gathered by the shores of Lough Gill are doubtfully referred to this species.

Carex rigida, Good. 2100 to 1700 feet.—On the summits of Ben Bulben and Truskmore. No specimens of *C. rigida* can be found among Corry's plants; his height doubtful.

,, *glauca*, Scop. 2000 feet.—Common.

,, ,, var. *stictocarpa*, a curious form gathered on the north face of Ben Bulben, has been referred by Mr. Bennett to this variety.

,, *vulgaris*, Fries.—Frequent.

,, *pilulifera*, Linn.—Frequent.

,, *præcox*, Jacq.—On the talus. An abnormal depauperated form with perygynia not developed, &c., having terminal ovoid spikes, resembling the *capitata* group, was gathered.

[,, *pallescens*, Linn.—In Corry's List, and very likely to occur.]

,, *panicea*, Linn. 1700 feet.—Common.

,, *strigosa*, Huds.—Rare. Only seen by the roadside at west end of Glencar lake.

,, *sylvatica*, Huds. 1850 feet.—Common.

,, *lævigata*, Sm.—Rare. In a wood near Kinlough, and in a small wood between Ben Bulben and Ben Whisken.

,, *binervis*, Sm. 2100 feet.—Common.

,, *distans*, Linn.—Rare. Near Kinlough.

,, *hornschuchiana*, Hoppe.—In a field near foot of Ben Boo mountain.

,, *flava*, Linn. 1850 feet.—Common.

,, *ampullacea*, Good. 1400 feet.—In a bog on the mountain, between Glencar and Trusk.

,, *vesicaria*, Linn.—River side, Lough Gill.

Gramineæ.

Anthoxanthum odoratum, Linn. 2000 feet.—Common.

Digraphis arundinacea, Trin.—Lough Gill river.

Alopecurus geniculatus, Linn.—Near Drumcliff.

,, *pratensis*, Linn.—Whyte's Cottage, Glencar.

Phleum pratense, Linn.—Whyte's Cottage, near Manorhamilton, &c.

Sesleria caerulea, Scop. 1100 feet.—Abundant on cliffs.

Agrostis canina, Linn.—Near Milltown.

,, *alba*, Linn.—Near Drumcliff.

,, *vulgaris*, With.—Common.

Phragmites communis, Trin.—Common.

Aira caespitosa, Linn.—Frequent about Glencar, &c.

,, *flexuosa*, Linn. Sea level to 2100 feet.—Frequent about Glencar, &c.

,, *caryophyllea*, Linn.—Milltown.

Avena flavescens, Linn.—Whyte's Cottage, Glencar.

,, *elatior*, Linn.—Base of Ben Bulben, &c.

Holcus lanatus, Linn.—Common.
Triodia decumbens, Beauv.—Frequent.
Koeleria cristata, Pers.—Very common on the mountains.
Molinia cærulea, Moench.—Common. The form *major*, Roth, with green spikelets, and the panicle long and lax, occurs on Ben Boo mountain.
Melica uniflora, Retz.—Wood at Glencar.
Catabrosa aquatica, Beauv.—Local. Roadside near Manorhamilton.
Glyceria fluitans, Brown.—Common.
,, *plicata*, Fries.—Local.
Poa annua, Linn.—Common.
,, *alpina*, Linn. 1950 to 1500 feet.—Frequent at the summit of Ben Bulben, and at Annacoona.
,, *pratensis*, Linn.—Frequent.
,, *trivialis*, Linn.—Common.
Briza media, Linn.—Glencar, &c.; frequent.
Cynosurus cristatus, Linn.— Common.
Dactylis glomerata, Linn.—Common.
Festuca sciuroides, Roth.—Scarce. Dry fields, Glencar, &c.
,, *ovina*, Linn.—Frequent, and generally viviparous on the mountains.
,, *rubra*, Linn.—Abundant on the hills.
,, *elatior*, Linn.—Glencar, &c.; not common.
,, *pratensis*. (?) Huds.
Bromus asper, Murr.—Glencar, &c.
,, *commutatus*, Schrad.—Scarce; near Milltown.
,, *mollis*, Linn.—Common.
Triticum repens, Linn.—Common.
Lolium perenne, Linn.—Common.
† ,, *italicum*, Braun.—Frequent in laid down pastures.
Nardus stricta, Linn.—Very common on the hills.

FILICES.

Hymenophyllum unilaterale, Willd. 850 feet.—On cliffs near Annacoona.
Adiantum capillus-veneris, Linn.—Three or four plants only seen at one place on the cliffs of Glencar. The exact locality must be known, as some one had evidently been there a few hours before us removing specimens, and it will doubtless be completely exterminated very soon.
Pteris aquilina, Linn.—Common.
Lomaria spicant, Desv. 2000 feet.—Common.
Asplenium ruta-muraria, Linn. 1450 feet.—Frequent on the cliffs.
,, *trichomanes*, Linn.—Common on cliffs.
,, *viride*, Huds. 1600 feet.—Scarcely a plant on Ben Bulben, but abundant on many other cliffs, and in the deep holes through the mountains
,, *adiantum-nigrum*, Linn.—In the wood on north side of Glencar lake.

Athyrium filix-fœmina, Bernh. 1750 feet.—Common.

Scolopendrium vulgare, Sm.—Common. Many plants were met with in which the fronds were divided, and some brought home have proved to be persistent.

Cystopteris fragilis, Bernh. 1700 feet.—Common all over the mountains.

Aspidium lonchitis, Sw. 1600 feet.—Only one plant seen on Ben Bulben by Vowell in 1882; none seen in 1884. Common in parts of Glenade; and at Octagorea some very fine specimens were gathered; fronds over eighteen inches long. The form with the pinnæ overlapping was rather scarce.

" *aculeatum*, Sw.—Only seen at Glenade.

" *angulare*, Willd.—Common.

Nephrodium filix-mas, Rich. 1850 feet.—Common.

" *dilatatum*, Desv. 2100 feet.—Common.

" *æmulum*, Baker.—Glencar and Glenade, and in many other places about the mountains.

" *oreopteris*, Desv.—On the talus of cliffs on south side of Glenade.

Polypodium vulgare, Linn.—Frequent. The var. *hibernicum* was gathered on Goat Island, Lough Gill.

Osmunda regalis, Linn.—Shore of Lough Gill.

Ophioglossum vulgatum, Linn.—Near base of Arroo mountain, Kinlough.

Lycopodiaceæ.

Lycopodium selago, Linn. 2100 to 270 feet.—Common on the mountains.

" *alpinum*, Linn.—Recorded in *Cyb. Hib.* as having been found on the mountains of Sligo by Mr. J. Wynne, but not seen by us, nor by Mr. Corry.

Selaginella selaginoides, Gray.—Frequent.

Equisetaceæ.

Equisetum arvense, Linn. 1050 feet.—Common.

" *maximum*, Lam.—Abundant in some places.

" *sylvaticum*, Linn. 1200 feet.—Generally distributed, but not common.

" *palustre*, Linn. 1400 feet.—Frequent.

" *limosum*, Linn.—Lough Gill, Glenade.

" *mackaii*, Newman.—Glencar, in hedge by side of road at north-west end of lake.

CHARACEÆ.

Chara aspera, Willd. var. *subinervis*.—Glenade lake, and Lough Gill river.
,, *fragilis*, Desv.—Lough Gill river, near Sligo.
,, ,, var. *hedwigii*.—Lough Gill river, near Sligo.
,, ,, var. *delicatula*.—Glenade lake, Leitrim.
,, *vulgaris*, Linn. var. *longibracteata*.—Glencar lake, Sligo.

Tolypella glomerata, Leonh.—In Glencar lake, and also in Glenade.

XXVI.—Note on a Geometrical Method of Investigating the Dynamical Properties of the Cylindroid. By Robert S. Ball, LL.D., F.R.S., Royal Astronomer of Ireland.

[Read, May 11, 1885.]

It is a fundamental point in the theory of screws, that when a certain condition is fulfilled between two screws they are 'reciprocal,' *i.e.* a twist on either does no work against a wrench on the other. If a, b be the pitches of the two screws, and if d be their shortest distance apart, and θ be the angle between them, then the condition that they shall be reciprocal is thus stated:

$$(a + b) \cos \theta - d \sin \theta = 0.$$

Let α and β be any two screws, then if a body receives a twist about α, followed by another twist about β, the position arrived at could have been reached by a single twist about a third screw γ. If the amplitudes of the twists about α and β are given, then the position of γ, as well as the amplitude of the resultant twist thereon, are, of course, both determined. If, however, the amplitudes of the twists on α and β are made to vary while the screws α and β themselves remain fixed, then the position of γ, no less than the amplitude of the resultant twist, must both vary. A little reflection will, however, show that the *position* of γ will remain constant so long as the ratio of the amplitudes of the twists about α and β remains unchanged. As this ratio varies, the position of γ will vary, so that this position is a function of a single parameter; and, accordingly, γ must be restricted to be one of the generators of a certain ruled surface, which includes α and β as extreme cases in which the ratio is zero and infinity respectively.

It is proposed herein to investigate the nature of this ruled surface by the Theory of Reciprocal Screws. The real character of this surface, which is called the cylindroid, is of course well known, as it forms a fundamental part of the Theory of Screws. It is only the method of investigation which forms the novelty in this communication.

Let θ be a screw which is reciprocal to both α and β, then it will be obvious that θ must also be reciprocal to γ; for suppose a wrench on θ, then a body can be twisted about α and β without any expenditure of work. If the body be restored to its original position by a twist backwards along γ, then no work can be done during this operation, for otherwise there would be a quantity of energy created or lost. It must not, however, be supposed that the theorem of the reciprocity of θ and γ is limited only to the case of a system of forces in which the doctrine of the conservation of energy is true. For the

convenience of demonstration we have regarded the forces as conservative; but it is to be remembered that the condition of reciprocity is a purely geometrical one, involving only a certain metrical relation between the positions of the two screws and their pitches. We adduce the case of a conservative system of forces merely to show that this condition must be observed between θ and γ. This being so, the relation of reciprocity is true whatever be the forces which constitute the wrench.

We proceed to study the consequences of the reciprocity of θ to the group of screws typified by γ, lying on the surface S. Let there be four screws, θ_1, θ_2, θ_3, θ_4, drawn reciprocal to any two screws of S: since a screw is defined by five conditions, it is plain that a screw which fulfils the four conditions of being reciprocal to θ_1, θ_2, θ_3, θ_4 will have one degree of freedom, and must, therefore, be confined to a certain ruled surface. This surface must, of course, include S, as all on the screws on it are reciprocal to θ_1, θ_2, θ_3, θ_4; further, it cannot iuclude any screw not on S; for suppose it did contain a screw ϵ, then as ϵ and *any* screw γ on S are reciprocal to θ_1, θ_2, θ_3, θ_4, it will follow that any screw on the surface made from ϵ and γ, just as S is made from a and β, must also be reciprocal to θ_1, θ_2, θ_3, θ_4. As γ may be selected arbitrarily on S, we would thus have the screws reciprocal to θ_1, θ_2, θ_3, θ_4 limited not to one surface, but to a whole group of surfaces, which is impossible. It is therefore the same thing to say that a screw lies on S, as to say that it is reciprocal to θ_1, θ_2, θ_3, θ_4.

Since the condition of reciprocity involves the pitches of the two screws in an expression containing only their sum, it follows that if all the pitches on θ_1, θ_2, θ_3, θ_4 be increased by $-m$, and all those on S be increased by $+m$, the reciprocity will be undisturbed. Hence, if the pitches of all the screws on S be increased by $+m$, the surface so modified will still possess the property, that twists about any three screws will neutralize each other if the amplitudes be properly chosen.

We can now take a step in our study of S, and show that there cannot be more than two screws of equal pitch thereon; for suppose that there were three screws of pitch m, if we then apply the constant $-m$ to all, we shall have on S three screws of zero pitch. It must therefore follow that three forces on S can be made to neutralize; but this is obviously impossible, unless these forces intersect in a point and lie on a plane. In this case the whole of S degrades to a plane, and the case is a special one devoid of interest for our present purpose. It will, however, be seen that in general S does possess two screws of any given pitch, for it is well known that a wrench can always be decomposed into two forces in such a way that the line of action of one of these forces is arbitrary. Suppose that S only possessed one screw λ of pitch m. Reduce this pitch to zero; then any other wrench must be capable of decomposition into a force on λ (*i. e.* a wrench of pitch zero), and a force on some other line which must lie on S; therefore in its transformed character there must be a

second generator of zero pitch on S, and, therefore, in its original form there must have been two screws of the given pitch m.

Intersecting screws are reciprocal if they are rectangular, or if their pitches be equal and opposite; hence it follows that a screw θ reciprocal to S must intersect S in certain points, the screws through which are either at right angles to θ or have an equal and opposite pitch thereto.

From this we can readily show that S must be of a higher degree than the second; for suppose it were an hyperboloid, then a transversal θ which intersected two screws of equal pitch m must, when it receives the pitch $-m$, be reciprocal to the entire system. We can take for θ one of the generators on the hyperboloid; θ will then intersect every screw of the surface; it must also be reciprocal to all these; and, as there are only two screws of the given pitch, it will follow that θ must cut at right angles every generator of one species. The same would have to be true for any other reciprocal screw θ lying on the surface; but it is obvious that two lines θ and ϕ cannot be found which will cut all the generators at right angles, unless, indeed, in the extreme case when all these are coplanar and parallel. In the general case it would require two common perpendiculars to two rays, which is, of course, impossible. We hence see that S cannot be a surface of the second degree.

We have thus demonstrated that S must be at least of the third degree —in other words, that a ray which pierces the surface in two points will at least pierce it in one more. Let α and β be two screws on S of equal pitch m, and let θ be a screw of pitch $-m$ which intersects α and β. It follows that θ is reciprocal both to α and to β, and therefore it must be reciprocal to every screw of S. Let θ cut S in a third point through which the screw γ is to be drawn, then θ and γ are reciprocal; but they cannot have equal and opposite pitches, because then the pitch of γ should be equal to that of α and β. We would thus have three screws on the surface of the same pitch, which is impossible. It is therefore necessary that θ shall always intersect γ at right angles. From this it will be easily seen that S must be of the third degree; for suppose that θ intersected S in a fourth point, through which a screw δ passed, then θ would have to be reciprocal to δ, because it is reciprocal to all the screws of S; and it would thus be necessary for θ to be at right angles to δ. Take then the four rays α, β, γ, δ, and draw across them the two common transversals θ and ϕ. We can show, in like manner, that ϕ is at right angles to γ and δ. We would thus have θ and ϕ as two common perpendiculars to the two rays γ and δ. This is impossible, unless γ and δ were in the same plane, and were parallel. If, however, γ and δ be so circumstanced, then twists about them can only produce a resultant twist also parallel to them, and in the same plane. The entire surface S would thus degenerate to a plane.

We are thus conducted to the result that S must be a ruled cubic surface of the third degree, and it will now be easy to find out its com-

plete character. Since any transversal θ across α, β, and γ may be a reciprocal screw, if its pitch be equal and opposite to those of α and β, it will follow that each such transversal must be at right angles to γ. This will at once restrict the situation of γ, for it is obvious that unless it be specially placed with respect to α and β, the transversal θ will not always fulfil this condition. Imagine a plane perpendicular to γ, then this plane contains a line I at infinity, and the ray θ must intersect I as the necessary condition that it cuts γ at right angles. As θ changes its position, it traces out a quadric surface, and as I is one of the generators of that quadric, it must be an hyperbolic paraboloid. The three rays α, β, γ, belonging to the other system on the paraboloid must also be parallel to a plane, being that defined by the other generator I', in which the plane at infinity cuts the quadric.

Let PQ be a common perpendicular to α and γ, then since it intersects γ at right angles, it must also intersect I; and since PQ cuts the three generators of the paraboloid α, γ, and I, it must be itself a generator, and therefore intersects β. But α, β, γ are all parallel to the same plane, and hence the common perpendicular to α and γ must also be a perpendicular to β. We hence see the important result, that all the screws on the surface S must intersect the common perpendicular to α and β, and be at right angles thereto.

The geometrical construction of S is then as follows:—Draw two rays α and β, and also their common perpendicular λ. Draw any third ray θ, subject only to the condition that it shall intersect both α and β. Then the common perpendicular ρ to both θ and λ will be one of the generators of the cylindroid, and as θ varies this perpendicular will trace out the surface.

In the language of modern geometry, θ is one of the rays of the congruence defined by α and β. A congruence is a doubly infinite system of right lines, and it might at first sight appear that there should be a doubly infinite series of common perpendiculars ρ to λ and θ. Were this so, of course S would not be a surface. The difficulty is removed by the consideration that *every* transversal across ρ, α, β is perpendicular to ρ; thus for each ρ there is a singly infinite number of screws of θ. And thus all the rays ρ form only a singly infinite series, *i. e.* a surface.

A simple geometrical relation will now be very easily proved. Let the perpendicular distance between ρ and α be d_1, and the angle between ρ and α be A_1; let d_2 and A_2 be the similar quantities for ρ and β, then it will be obvious[1] that

$$d_1 : d_2 :: \tan A_1 : \tan A_2;$$

or
$$d_1 + d_2 : d_1 - d_2 :: \sin(A_1 + A_2) : \sin(A_1 - A_2),$$

if z be the distance of ρ from the central point of the perpendicular h

[1] It is easy to make a rough model of the paraboloid with elastic threads, which is an assistance in the study of the surface.

between α and β; and if ϵ be the angle between α and β, and θ be the angle made by ρ with a parallel to the bisector of the angle ϵ, then we have from the above

$$z : h :: \sin 2\phi : \sin 2\epsilon.$$

The equation of the surface S is now deduced for

$$\tan \phi = \frac{x}{y};$$

whence we obtain the equation of the cylindroid in the well-known form

$$z(x^2 + y^2) = \frac{2h}{\sin 2\epsilon} xy.$$

The law of the distribution of pitch upon the cylindroid can also be deduced from the same principles. If α and β are screws of zero pitch, then any reciprocal transversal θ will be also of zero pitch; and as ρ must be reciprocal to θ, it will follow that the pitch of ρ must be equal to the product of the shortest perpendicular distance between ρ and θ, and the tangent of the angle between the two lines. In short, the pitch of ρ must simply be equal to what is sometimes called the *moment* between ρ and θ.

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XXVII.—PRELIMINARY REPORT ON THE FAUNA OF DUBLIN BAY. By ALFRED C. HADDON, M.A., M.R.I.A., F.Z.S. &c., Professor of Zoology, Royal College of Science, Dublin.

[Read, February 23, 1885.]

IN 1881 the Academy gave a grant to Mr. A. G. More and myself to investigate the Marine Fauna of Dublin Bay. Mr. More having been prevented by ill health from taking any active share in the work, the duty of reporting to the Academy has devolved upon me.

I have purposely entitled this communication a "Preliminary Report," as I am still investigating the fauna of the Bay as opportunity presents itself; and since additions are continually being made to our knowledge, I consider it would be a mistake to present a final Report to the Academy until it could be reasonably expected to be fairly exhaustive, but some account of the duty entrusted to me is by this time due to the Academy.

As a rule, I have confined the following account to an enumeration of those forms which have not previously been recorded as occurring in the Bay or neighbouring coast, or which are otherwise of interest. I have taken the lists compiled for the Dublin Meeting of the British Association in 1878, by Prof. H. W. Mackintosh and others, and the localities recorded in the various monographs,[1] as my authorities for the presence or absence of any particular form on our coasts.

I should like to take this opportunity of thanking the following gentlemen who have assisted me, viz., Mr. T. A. Bewley for a dredging excursion in a steam-launch, in conjunction with Messrs J. Wright of Belfast, and Mr. F. Balkwill, late of Dublin; Dr. W. Wright of Dalkey, for one afternoon in his yacht, and to Mr. G. Y. Dixon and others of Dublin, for help in shore-collecting at various times. Mr. A. G. More, with characteristic readiness, has always responded to any appeals for advice. The square brackets [ ] include species added since the Report was read.

Protozoa.—The Foraminifera of this district have already been investigated by Messrs F. Balkwill and J. Wright, and their Report was published by the Academy in 1885, (*Trans.* XXVIII., p. 317). I have, therefore, paid no attention to this group, but when examining some Polyzoa, which I had collected in the summer of 1882 at Dalkey Island, in a sheltered spot, between tides, I found several specimens of *Haliphysema tumanowiczii*, Bowk. This remarkable arenaceous Rhizopod has had a chequered history since its discovery by Bower-

[1] Guide to the City and County of Dublin, 1878. Dublin: Hodges, Foster, & Figgis. (Part II., Fauna.)

bank; full references to the literature will be found in H. B. Brady's "Report on the Foraminifera," *Challenger Reports*, vol. ix., p. 281. I found it in material which had been preserved in alcohol, and though I have since searched for it I have not had the good fortune to come across it again, and, therefore, have no contributions to offer concerning its life-history. Messrs Balkwill and Wright have recorded this Rhizopod on p. 354 of their Report. The second species, *H. ramulosum*, Bowk., has been found in Roundstone Bay by Rev. A. M. Norman.

I have made no attempt at present to systematically examine other groups of marine Protozoa.

Porifera.—I have no sponges to add to the British Association List. The largest *Grantia* (*Sycandra*) *compressa*, Fabr., I have seen was one given me by Mr. G. Y. Dixon, when we were shore collecting at Salthill. He found it in a shallow rock-pool, and it measured two inches long by three-quarters of an inch broad.

Coelenterata, Hydrozoa.—Dalkey Island is a rich locality for the gymnoblastic hydroids. I have collected the following at the S.W. corner of that Island:—*Coryne pusilla*, Gärtn.; *C. vaginata*, Hincks, the latter growing luxuriantly; *Garveia nutans*, T. S. Wr. So far as I am aware this small but beautiful hydroid has hitherto only been recorded from the Firth of Forth, Shetland, and Morecambe Bay.[2] I found it associated with *Tubularia humilis*, Allm., and *T. indivisa*, Linn., in a sheltered pool. The only other recorded locality for *T. humilis* being Kinsale Harbour, G. J. Allman.[3]

I have found *Eudendrium capillare*, Ald., in Dublin Bay, the previously recorded localities being Firth of Forth, Northumberland, Cornwall and Devonshire. *Hydractinia echinata*, Flem., is common everywhere.

The following are the additions to the calyptoblastic hydroids of our coasts:—*Obelia flabellata*, Hincks, previously only recorded from Tenby and Scotland. *Gonothyraea lovéni*, Allm., on various hydroids:

[2] The recently established Liverpool Marine Biology Committee, under the charge of Prof. Herdman, dredged this form five or six miles off the Great Ormes Head, N. Wales, from fourteen fathoms. Cf. *Liverpool Daily Post*, May 20, 1885.

[3] On June 27, 1885, in company with my former pupils, Mr. H. W. and Miss Jacob, we dredged in Scotch Bay, Kingstown, near the shore, the two following Hydroids, which are new to Ireland—*Syncoryne eximia*, Allm., growing on seaweed; owing to the absence of any gonophors, the identification is not absolutely certain, although I have no doubt about it in my own mind. We also had the good fortune to obtain two specimens of *Corymorpha nutans*, Allman. Haeckel in his *Das System der Medusen*, p. 31, states that the *C. nutans* of Allman and Hincks is not the same as the *Corymorpha nutans* of Sars. The latter has priority of name, and stands as *C. nutans* with *Hybocodon nutans* as its medusoid form. It is generally admitted that *Steenstrupia rubra* and *S. flaveola*, Forbes, are one and the same species, and form the medusoid form of the British *C. nutans*. Haeckel takes the unwarranted liberty of ignoring Forbes' priority, and renames the medusa as *Steenstrupia galanthus*, Haeck., the hydroid form being *Corymorpha galanthus*, Haeck. I am at present unable to discuss the question of the distinctness of the *C. nutans* of Sars and of Allman, but hope to do so at no very distant date. In the meantime there is no doubt that a species of Corymorpha occurs at Kingstown.

some specimens collected appear to be intermediate between this form and *G. hyalina*. The latter has only been obtained from Shetland. *Lafoëa pocillum*, Hincks, previously recorded from Oban Bay, and "very rare, on Eudendrium, at Monkstown, D. St. J. Grant," (B. A. List, p. 4.). I have found it on *Diphasia attenuata;* it is very rare. *L. pygmæa*, Alder, is also rare; previously recorded from Tynemouth and Sark. The rarity of these two species is probably more due to their small size and their being inconspicuous, than to their being absent in other localities. This is also the first recorded Irish locality for *Diphasia attenuata*, Hincks.

Especial attention has been paid to the Medusæ of the Bay, as they are forms which possess great interest, apart from their beauty of shape and colour. It is very desirable that a Monograph of the British members of this group should be written, as Forbes' Ray Society Monograph, beautiful and invaluable as it is, is necessarily somewhat out of date (1848). With the works of Forbes, Allman, Hincks, Hæckel, and others to refer to, and the modern facilities for research, such an undertaking is easy, compared with the difficulties Forbes had to contend against.

Steenstrupia rubra, Forbes (= *S. flaveola*, Forbes), was found in June, 1884, in Dalkey Sound; it is the medusa-form of *Corymorpha nutans*, Allman (*non* Sars *fide* Hæckel). J. R. Greene, in the British Association Report for 1857 (Dublin), records a Steenstrupia from the Dublin coast, but no details are given; and Alder found *Corymorpha nutans* in the Isle of Man. So far as I am aware, this is the whole history of this beautiful and remarkable species in the Irish seas. The Medusa had evidently not long been liberated from the parent stock, as the single tentacle was quite short. I kept it alive for a day or two, and the tentacle grew to about the length depicted in most of the figures. The fixed form must therefore be regarded as an inhabitant of Dalkey Sound or its immediate neighbourhood. [*S. rubra* is very common in Kingstown Harbour in June, and, as noted above, the hydroid form is now proved to occur in Scotch Bay.]

Several species of Sarsia occur: one I identified as *S. tubulosa*; another perfectly agrees with Patterson's description of a form met with at Larne, in Forbes' Monograph, p. 56, and which I propose provisionally to name *S. pattersoni*, sp. nov. *Tiara octona*, Forbes (= *Oceania turrita*, Forbes, and *O. coronata*, Allm., according to Hæckel), occurred once. The genus "Thaumantias" is represented by several species, among which I have identified *T. hemisphericа*, Gron.; *T. inconspicua*, Forbes; and *T. globosa*, Forbes. The latter is, according to Hæckel, *Phialidium variabile* (= *Oceania phosphorica* + *O. flavidula*, Per. and Les. 1809; = *Thaumantias sarnica* + *T. convexa* + *T. globosa*, Forbes, 1848; = *Eucope variabilis*, Claus, 1864, &c., &c.). Our knowledge of the forms usually included under the genus Thaumantias is at present in a very unsatisfactory condition, as Hæckel and others have shown; the genus is undoubtedly polymorphic, and the char-

acters of the included species are in many cases so ill-defined as to render identification very difficult.

[*Margelis britannica*, Forbes (= *Medusa duodecilia*, Dalyell), was common in June, 1885, at Kingstown and Dalkey. L. Agassiz (1862) and Hæckel (1879) refer *Bougainvillea britannica*, Forbes, to the genus Margelis, but Allman (1872) retains the genus. There is sufficient evidence that this is the medusoid form of *Eudendrium ramosum*, van. Beneden (1844), (the *B. ramosa* of Allman's Monograph). According to the strict law of priority, Forbes' species (described as *Hippocrene britannica* in 1841); has precedence of van Beneden's, but both Allman and Hæckel agree in adopting the latter zoologist's name: Allman does so "in the absence of absolute proof of this specific identity;" Hæckel gives no reason. The alteration of the specific name merely depends upon the identity of the two forms in question, and since this is no longer doubted it is clearly our duty to accept the less appropriate specific name of Forbes. Agassiz's generic name, Margelis, will be provisionally adopted. The remarkable medusa *Dipleurosoma hemispherica*, Allm., with its irregular gastrovascular canals and generative glands, was very common on June 27th, 1885, at Kingstown. Allman first described it in *Nature*, vol. ix., 1873, p. 73, as *Ametrangia hemispherica* (nov. gen. et spec.), from the south coast of Ireland. Hæckel, on p. 636 of his *Monograph of the Medusæ*, relegates this medusa to what is possibly its correct genus, and very characteristically changes the specific name to *D. irregulare*, Hæck., without stating any reason for so doing. It is true that Allman's name is not particularly well chosen, as there is a Thaumantias of the same name, but the rules of priority of nomenclature can not be set aside solely to introduce a more diagnostic term. Hæckel states he also met with this medusa in the spring of 1879, in the neighbourhood of Portobello, Brighton (Sussex). The present is the third record of its capture.]

Strangely enough, I have only seen *Aurelia aurita*, Linn., in July, 1881, in Kingstown Harbour [and *Rhizostoma octopus*, Linn. (= *R. pulmo*, Forbes, not of Linn.); at Dalkey in June, 1885: one specimen of the latter must have been two feet six inches in length, and proportionately broad.]

Only on one occasion, and that was in Dalkey Sound, in September, 1883, did I come across a siphonophore. The specimen was very small, $\frac{3}{16}$ths inch in length, and was too immature to be identified with anything like certainty; I doubtfully refer it to *Agalmopsis sarsii*, Köll. In the *Natural History Review*, vol. iii., 1856, p. 76, pl. vi. figs. 3, 4; and pl. vii. fig. 1, is an account of a siphonophore named *Stephanomia contorta*, M. Edw., two specimens of which were found by Prof. J. R. Greene, on June 2, 1856, in Kingstown Harbour, in a calm sea, during hot sultry weather. At the same time was published a notice of *Agalma gettyana*, Hyndman, which was seen by Mr. Edmund Getty in great numbers in Belfast Bay, in August, 1841, and also in July, 1852, by Mr. Hyndman, in great abundance in the

same bay (pl. vii., fig. 2). Dr. Melville considered that these two were specifically identical. In the British Association Report for 1857 (Dublin), p. 103 of the Sectional Communications, Prof. J. R. Greene states that "the siphonophoræ were represented by the beautiful *Agalmopsis* of Sars." When I add that there are dried specimens of *Velella spirans* (?) from Dalkey (presented by Dr. J. Tufnell), collected on September 5, 1867, I have recorded all I have been able to gather concerning the occurrence of this most interesting group of Hydrozoa in Dublin Bay. *Cydippe* (*Pleurobrachia*) *pileus* (?) is very abundant. I am under the impression that we have more than one species of Cydippe. I have only one specimen of a Beroe.

ACTINOZOA.—*Edwardsia* sp. *incert.* This is a minute specimen 18mm. (¾ inch) in length, of a uniform pale pink colour, which I found on June 27, 1881, at Salthill, in dirty sand, between tides, but which has not been met with since. It appears to be a new species, but, being undoubtedly immature, I will not venture to describe it. It would not be out of place to here mention *Halcampa chrysanthellum*,[4] which was discovered by my friend and former pupil, Miss A. Shannon, at Malahide, on September 14, 1883, and which I have described and figured in the *Proceedings, Royal Dublin Society*, N. S., vol. iv., 1885, p. 396; also in the same number of that Journal will be found, p. 399, an account of the habits, and a full description, with plates, of *Peachia hastata*, Gosse, first discovered in Dublin Bay by Mr. G. Y. Dixon, and exhibited by him at the Dublin Society, on November 14, 1884. So far as I am aware, this is the first time that any member of the three families to which the above severally belongs has been found in Ireland.

Heliactis (*Sagartia*) *bellis*, Ellis, occurs at Malahide. *H.* (*S.*) *venusta*, Gosse, has been found by Mr. Dixon and myself at Dalkey Island. I hope on a future occasion to publish a revised list of our Irish Anemones; in the meantime I fully concur with Prof. Andres in regarding *S. rosea*, *S. nivea*, and *S. aurora* of Gosse, as varieties of *H. venusta*, Gosse; the two former occur at Dalkey Island, and I have dredged *H.* (*S.*) *miniata*, Gosse, off Bray Head, in twenty-three fathoms, and it also occurs at Dalkey. *Cylista undata*, Müll. (= *Actinia troglodytes*, Johnst., has been found both at Monkstown and Dalkey.

[On June 3, 1885, in Kingstown Harbour, and again on June 20, at Dalkey,[5] I caught in the tow net a Thaumantias, with a minute Anemone attached to its stomach on the sub-umbrella; both were a little under 3mm. in length. The first was killed after keeping it alive a day or two, and it, together with the second living specimen, was exhibited at the Academy, at the meeting on June 22. The latter

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[4] Having recently had several specimens of Halcampa from Malahide, and finding that they all vary, I feel it would be wiser to withdraw the name (*H. andresii*) I gave to this specimen, and to refer them all to *H. chrysanthellum*, Peach. I propose to publish a note on this species.

[5] Mr. Jacob brought me two other specimens from Dalkey on July 3, 1885.

was alive up to the time of going to press; it was fed with living specimens of "Thaumantias." It has undergone several developmental phases, being at first of a uniform yellowish colour, with rudimentary tentacles; though short, the tentacles grew longer, and were tinged with brown and yellowish white; the disk also became variegated, and the body translucent, revealing the yellow œsophagus. Strethill Wright, in *Proc. Phys. Soc.*, *Edinb.*, ii., 1859, p. 91, and again, in *New Edinb. Phil. Jour.*, vii., 1860, p. 156, which was reprinted in *Ann. Mag. Nat. Hist.* (3), viii., 1861, p. 132, published a somewhat imperfect account of two specimens of an Anemone parasitic on Thaumantias from the Firth of Forth. I can find no printed record of another similar capture in England; but Prof. A. Macalister, M.D., F.R.S., of Cambridge (late of Dublin), informs me, by letter, that he has met with the *Halcampa fultoni*, St. Wright, and perhaps with another form, but not in Dublin Bay. As my observations on this interesting anemone are not yet completed, I forbear from describing it, but I hope in due course to be in a position to give a complete and illustrated account of its structure and further development. For the present I will merely state that S. Wright's specimens had twelve tentacles and mesenteries, and, if so, probably belonged to the genus *Bicidium* Agassiz (= *Philomedusa*, Müller?). The Irish specimens have eight tentacles, but twelve mesenteries. There is a remarkable double bi-lateral symmetry in this Anemone—one axis is marked by a single tentacle at each end of the disk, with a lateral group of three on either side, the spaces between the single tentacles and the groups being markedly greater than those between the units of the latter. The twelve mesenteries are so arranged that there is an intermesenterial chamber without a corresponding tentacle on each side of the single tentacles. The second axis is at right angles to the former, and is marked by a deep notch of the wide mouth opposite to the central tentacle of one of the groups of three. This must be regarded as a siphonoglyphe, as it is ciliated; the cilia appear to work outwards.[6]

[Mr. Jacob dredged *Caryophyllia smithii*, Stokes, var. *esmerelda*, on June 6, 1885, under the Martello Tower on Dalkey Island, close to the shore. *Antedon rosacea*, Link., was very abundant at the same spot.]

I have only *Echinocyamus pusillus* to add to the B. A. List of **Echinodermata;** it was dredged off Bray Head, in twenty-three fathoms, together with *Echinus miliaris*, Müll. It is common in Belfast Lough and other parts of the coast.

[On September 24, 1885, Mr. Jacob, and on the 26th, Mr. G. Y. Dixon, each found a single specimen of *Synapta inhærens*, O. F. Müll., at Malahide. It is very remarkable that this is the first time, so far

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[6] Since writing the above the Anemone has died. The missing tentacles had just commenced to appear; and although I have, at present, nothing much more definite to add to the above account, I am strongly inclined to regard this parasite as the larval form of *Halcampa chrysanthellum*.

as I can learn, of any Holothurian having been found in Co. Dublin, especially as so many species of Holothuria have been found in Co. Down.]

Vermes.—The following Platyhelminths have been met with :—*Planaria ulva*, Oerst.; *Tetrastemma dorsalis*, Abildg.; *T. candida*, O. F. Müll.; *T. flavida*, Ehren.; *Lineus marinus*, Mont., and a species of Amphiporus, which I believe to be new. All were found at Salthill. *Amphiporus lactifloreus*, Johnst., is common at Malahide.

[Mr. Jacob dredged *Carinella annulata*, Mont., on June 6, 1885, in Dalkey Sound.]

Over two dozen species of Annelida have been collected and preserved. I am at present working at this group, and so refrain from detailing my captures. The remarkable pelagic annelid, *Tomopteris scolopendra*, Quoy and Gaim., once occurred in Kingstown Harbour (August 26, 1883). Mr. R. Ball records that *Bryarea scolopendra* was taken in Dublin Bay by Dr. Corrigan (*Report Brit. Association*, 1849, p. 72). Prof. Allman captured some young specimens in 1873, on the south coast of Ireland (*Nature*, ix., 1873, p. 74). Dr. E. Perceval Wright has several times caught it on the south-west coast (*Rep. Brit. Assoc.*, 1860, p. 124), but this is a form which is widely distributed.

[*Sagitta bipunctata*, Krohn, was common at Kingstown in June, 1885.]

I have two undetermined species of Phascolosoma, of which I made careful drawings.

Most of the Polyzoa enumerated in the B. A. List have been identified. I would here merely state that *Pedicellina cernua*, Pall. (=*P. echinata*, Sards), is not at all rare at Salthill at extreme low water, where the sessile form of *Bowerbankia imbricata*, Adams, also occurs on Fucus. The only additions are *Diastopora obelia*, (?) Johnst., on Fucus at Salthill. *Bowerbankia caudata*, Hincks; *Scrupocellaria scrupea*, Busk., and *Ætea truncata*, Landsb.

I hope to procure the assistance of Prof. Herdman of Liverpool with the local Ascidians, of which I have collected a number of forms.

Mollusca.—The Nudibranchs are the only Molluscs to which I have any additions to make to the local list. I have met with the following in Kingstown Harbour: *Eolis drummondi*, Thomp.; *E. lineata*, Lovén.; *E. despecta*, Johnst.; *E. exigua*, Ald. and Hanc.—a variety of *E. exigua* of which I made the following note :—Similar in form and habit, body translucent white, mottled with green along each side below the branchiæ, one or two white dots about the insertion of the dorsal tentacles; foot as in *E. exigua*, but posterior extremity is long and slender; dorsal tentacles translucent, with one or two white dots near apex; branchiæ, shape much as in *E. exigua*, the yellowish alimentary cœca shining through, irregularly spotted with green, tip white. On *Campanularia flexuosa*, Kingstown Harbour, July 1, 1881. *Eolis* sq. *incert.* This species, together with an Eolis from Dalkey Island, I am withholding for the present; one or both may prove to be new species. All the species of *Eolis* mentioned above are new to

Dublin. *E. drummondi* is common in Belfast Lough; *E. lineata* is very rare, and has previously only been found at Saltcoats, Ayrshire, and Douglas, Isle of Man; *E. despecta* and *E. exigua* are probably widely distributed, but their small size and peculiar habit has, doubtless, caused them to be overlooked.

[*Proctonotus mucroniferus*, Ald. and Han.—It is with great satisfaction that I am able to record the recapture of this interesting and beautiful form. Messrs. Alder and Hancock state in their *Monograph*: "A single perfect specimen of this curious animal, and another much injured, were dredged up in Malahide Bay, in September, 1843, adhering to a sponge (*Halichondria panicea*), from rather shallow water." So far as I am aware, this species has only been met with since by Herdman, in Lamlash Bay, S.E. of Holy Isle, fifteen fathoms (*Proc., R. Phys. Soc., Edinb.*, 1881). I found two specimens on the under side of a large stone at extreme low water, on September 8, 1885, on the shore at Malahide. As in all their other descriptions, that of this form is very exact; there is, however, one point in which they have been misled. The dorsal processes (branchiæ) are arranged six deep, but immediately on putting the living animal into a dilute solution of chromic acid, for the purpose of conservation, all the three internal processes of each side were suddenly cast off in two long rows, leaving the three processes seen by Alder and Hancock; doubtless their specimens had similarly shed their processes whilst being dredged.

Alder and Hancock's specimens were not fully grown, as they state the length to be nearly half an inch, whereas mine measured 20mm. ($\frac{4}{5}$ths of an inch). I failed to notice that the anterior and posterior papillæ were larger than any other. The coloured core was absent in the anterior papillæ. The core of the papillæ was of a dark brown colour, and there were a number of irregular light lines in addition to the white and minute dark brown spots. The lines and light spots of the inner rows of dorsal papillæ were of a pale creamy burnt-sienna colour, those of the outermost rows were whiter. The animals were rather sluggish in habit, but bristled up their papillæ when excited. The spawn was a long, wavy, irregularly coiled thread.]

Doto coronata, Gmel., occurs at Kingstown, and *Dendronotus arborescens*, Müll., was found with all the above early in July, 1881, browsing upon the luxuriant growth of Campanularia, on the Laminaria which clothed the sides of the dredger; unfortunately this dredger has been kept so well tarred since that I have been unable to procure any more specimens from it. *Polycera quadrilineata*, Müll., occurred at Salthill. *Goniodoris nodosa*, Mont., occurs fairly plentiful at Malahide and at Salthill. *Doris tuberculata*, Cuv., was collected at Dalkey Island, and *D. pilosa*, Müll., is very common round Salthill.

During this last winter I have seen four specimens of *Eledone cirrosa*, Lamk., from Kingstown, and I have reason to believe that this octopod is not at all uncommon; sometimes it is left stranded by the

tide, but it is more frequently caught on fishing lines at the head of the pier.

Mr. H. W. Jacob has undertaken to work up the Irish **Crustacea**, so we may expect a report thereon from him in due course. I have handed over all my material to him.

I have made a practice of carefully preserving my captures, and have presented a set to the Natural History Museum, Kildare-street, where they can be examined by those interested in our marine fauna. With but one or two exceptions, all the forms mentioned above will be found in the Museum. In this matter I am pleased to find that I had anticipated the subsequently framed regulation of the Academy.

I would like to add that I shall be very pleased to communicate with anyone who is interested in marine zoology. Any specimens or information so obtained will be duly acknowledged.

XXVIII.—Note on the Character of the Linear Transformation which corresponds to the Displacement of a Rigid System in Elliptic Space. By R. S. Ball, LL.D., F.R.S.

[Read, November 9, 1885.]

I write the general linear transformation

$$y_1 = \overline{11}\,x_1 + \overline{12}\,x_2 + \overline{13}\,x_3 + \overline{14}\,x_4,$$

$$y_2 = \overline{21}\,x_1 + \overline{22}\,x_2 + \overline{23}\,x_3 + \overline{24}\,x_4,$$

$$y_3 = \overline{31}\,x_1 + \overline{32}\,x_2 + \overline{33}\,x_3 + \overline{34}\,x_4,$$

$$y_4 = \overline{41}\,x_1 + \overline{42}\,x_2 + \overline{43}\,x_3 + \overline{44}\,x.$$

It is known that this is too general to denote the displacement of a rigid system in elliptic space. It must be specialized so that a certain quadric surface (as a matter of fact there is a family of quadric surfaces) shall be displaced upon itself. This implies one condition, but only one, to be satisfied by the sixteen coefficients $\overline{11}$, $\overline{12}$, &c. The algebraical character of this condition has not, so far as I know, been hitherto pointed out. It is of an interesting nature, though I have not thought it necessary to attempt the portentous task of developing its actual expression. We shall first ennunciate the theorem, and then give the demonstration.

Form the biquadratic equation in ρ which is produced by the development of the determinant

$$\begin{vmatrix} \overline{11}-\rho, & \overline{12}\;\;, & \overline{13}\;\;, & \overline{14} \\ \overline{21}\;\;, & \overline{22}-\rho, & \overline{23}\;\;, & \overline{24} \\ \overline{31}\;\;, & \overline{32}\;\;, & \overline{33}-\rho, & \overline{34} \\ \overline{41}\;\;, & \overline{42}\;\;, & \overline{43}\;\;, & \overline{44}-\rho \end{vmatrix} = 0.$$

Let α, β, γ, δ be the four roots of this equation; then the symmetric function

$$(\alpha\beta - \gamma\delta)(\alpha\gamma - \beta\delta)(\alpha\delta - \beta\gamma)$$

having been formed gives, when equated to zero, the required condition.

The demonstration is as follows:—

If the four double points of the homographic systems be taken as points of reference; then

$$y_1 = h_1 x_1,$$

$$y_2 = h_2 x_2,$$

$$y_3 = h_3 x_3,$$

$$y_4 = h_4 x_4.$$

The requisite condition is obviously

$$h_1 h_2 = h_3 h_4,$$

for then the quadric surface

$$x_1 x_2 = H x_3 x_4,$$

will merely transform to the identical surface

$$y_1 y_2 = H y_3 y_4.$$

The condition admits of being stated geometrically. Each edge of the tetrahedron of reference possesses the property, that corresponding points thereon form two homographic systems, of which the two corners are the double points. Thus two corresponding points on 1 and 3 form with the corners the constant anharmonic ratio

$$\frac{h_1}{h_3}.$$

The two other corners of the tetrahedron define the double points of the systems whereof the two components make with the corners the constant ratio

$$\frac{h_4}{h_2};$$

but since $h_1 h_2 = h_3 h_4$, these two anharmonic ratios are equal, and hence we have the following theorem:—

If the linear transformation represents displacements; then two opposite edges of the tetrahedron are such, that the anharmonic ratio of two corresponding points, with the double points on one edge, is equal to the corresponding anharmonic ratio on the other edge.

This principle will prove the theorem which forms the subject of this Paper.

Let $a_1, a_2, a_3, a_4,$ and b_1, b_2, b_3, b_4

be the co-ordinates of two of the corners of the tetrahedron of double points in the general case; then we have

$$aa_1 = \overline{11}\, a_1 + \overline{12}\, a_2 + \overline{13}\, a_3 + \overline{14}\, a_4,$$

$$aa_2 = \overline{21}\, a_1 + \overline{22}\, a_2 + \overline{23}\, a_3 + \overline{24}\, a_4,$$

$$aa_2 = \overline{31}\, a_1 + \overline{32}\, a_2 + \overline{33}\, a_3 + \overline{34}\, a_4,$$

$$aa_4 = \overline{41}\, a_1 + \overline{42}\, a_2 + \overline{43}\, a_3 + \overline{44}\, a_4,$$

and similar equations beginning with γb_1, γb_2, &c.

Multiplying each of the second system of equations by λ, and adding to the first respectively, we have

$$aa_1 + \lambda\gamma b_1 = \overline{11}\,(a_1 + \lambda b_1) + \overline{12}\,(a_2 + \lambda b_2) + \overline{13}\,(a_3 + \lambda b_3) + \overline{14}\,(a_4 + \lambda b_4),$$

and three similar equations.

Hence we learn that the point corresponding to

$$a_1 + \lambda b_1, \quad a_2 + \lambda b_2, \quad a_3 + \lambda b_3, \quad a_4 + \lambda b_4,$$

is

$$aa_1 + \lambda\gamma b_1, \quad aa_2 + \lambda\gamma b_2, \quad aa_3 + \lambda\gamma b_3, \quad aa_4 + \lambda\gamma b_4,$$

so that the anharmonic ratio of these points and of a and b is

$$\frac{\gamma}{a};$$

but, by what we have just seen, this must be equal to

$$\frac{\delta}{\beta};$$

and hence $$a\delta - \beta\gamma = 0.$$

In other words, the product of one pair of the roots of the biquadratic must be equal to that of the other pair. The symmetric function

$$(a\beta - \gamma\delta)\,(a\gamma - \beta\delta)\,(a\delta - \beta\gamma)$$

must therefore vanish, and the required theorem has been proved.

The *pitch* of the twist which corresponds to the displacement can now be expressed in a very simple manner.

Let, as before, α, β, γ, δ be the four roots of the equation in ρ; then we must have some relation of the type

$$\alpha\gamma - \beta\delta = 0.$$

But we have also for the displacement of a point on $\alpha\gamma$, whose coordinates are

$$a_1 + \theta c_1, \quad a_2 + \theta c_2, \quad a_3 + \theta c_3, \quad a_4 + \theta c_4,$$

the points

$$a_1 + \theta\frac{\alpha}{\gamma}c_1, \quad a_2 + \theta\frac{\alpha}{\gamma}c_2, \quad a_3 + \theta\frac{\alpha}{\gamma}c_3, \quad a_4 + \theta\frac{\alpha}{\gamma}c_4;$$

and since the corners of the tetrahedron lie on the absolute, the distance moved is proportional to $\log\frac{\alpha}{\gamma}$, whence we deduce for the pitch the extremely simple equation

$$\frac{\log\alpha - \log\gamma}{\log\beta - \log\delta}.$$

In the case of a vector where the pitch is ± 1, we have

$$\frac{\log\alpha - \log\gamma}{\log\beta - \log\delta} = \pm 1,$$

and, of course,
$$\alpha\gamma = \beta\delta.$$

We hence see that either

$$\alpha = \beta \quad \text{and} \quad \gamma = \delta,$$

or
$$\alpha = \delta \quad ,, \quad \beta = \gamma.$$

This leads to another interesting theorem, which may be thus stated:—

When the movement is a "vector," then the necessary and the sufficient condition is, that the equation for ρ shall be a perfect square.

I take the opportunity of adding a theorem, which expresses the distribution of pitch upon the surface in elliptic space, which corresponds to the cylindroid in ordinary space.

The equation of the surface in its simplest type is

$$x_1 x_2(x_3^2 + x_4^2) = x_3 x_4(x_1^2 + x_2^2)\frac{a-b}{1-ab}.$$

XXIX.—On the Orbit of the Binary Star β Delphini. By J. E. Gore, M.R.I.A., F.R.A.S., Associate of the Liverpool Astronomical Society.

[Read, December 14, 1885.]

β Delphini has long been known as a wide double star, the companion being of the 11th magnitude, and distant about 34″ from the brighter star. In 1873, the eminent American observer, Burnham, discovered that the primary star was a very close double, and a few years' observations sufficed to show that it was a binary star in rapid motion. As the companion star has now described over 180° of its apparent ellipse, a satisfactory approximation to the elements of its orbit is possible.

I have computed the orbit by a graphical method, in which the dimensions and position of the real ellipse are derived from those of the apparent ellipse by means of Thiele's harmonic ellipse. This latter ellipse being the orthogonal projection of the harmonic circle on a plane perpendicular to the line of sight, its major axis is of course equal in magnitude to the *latus rectum* of the real ellipse, and its angle of eccentricity is the angle of inclination of the plane of the real ellipse to the plane of projection on the background of the heavens. Thus the magnitude and position of the real orbit can be fully determined.

This method of computing the orbit devised by Thiele (*Astronomische Nachrichten*, No. 1227) depends on the following geometrical property of the ellipse:—If a number of focal chords be drawn, and the harmonic means of the intercepts between the focus and curve be taken, and these means laid off from the focus along the chord on each side, the locus of the points thus found is a circle called the harmonic circle, the diameter of which is the *latus rectum* of the ellipse, and its centre the focus.

The following are the observations from which I have computed the elements:—

β DELPHINI.

ANGLES AND DISTANCES. EPOCH 1880·0.

R. A., 1880, $20^h\ 31^m\ 54^s$.
Decl. N., 14° 11′.
Magnitudes, 3·5, 4·5.

t	θ	r	No. of Nights.	Observer.
1874·66	15°·6	0″·61	5	Dembowski.
1874·80	15 ·1	0 ·4 ±	—	Schiaparelli.
1875·65	20 ·1	0 ·54	4	Dembowski.
1876·66	25 ·8	0 ·48	4	,,
1877·79	40 ·8	0 ·32	4	Burnham.
1878·65	53 ·7	0 ·24	4	,,
1878·70	59 ·2	oblong.	1	Dembowski.
1880·68	133 ·6	0 ·26	5	Burnham.
1881·50	149 ·2	0 26	5	,,
1882·60	167 ·5	0 ·26	3	,,
1883·25	183 ·90	0 ·194	—	Englemann.
1883·55	182 ·50	0 ·23	3	Burnham.
1884·71	197 ·75	0 ·32	—	Englemann.

These observations were plotted on squared millimetre paper, and an interpolating curve carefully drawn among them. A table was then formed of interpolated epochs for position angles differing by 5°, by readings from the interpolating curve. These were then corrected by adjusting the second and third orders of differences so as to "smooth" the curve. The radius vector for each angle was then found from the differences of epoch and angle by the formula $r = C\sqrt{\frac{\Delta t}{\Delta\theta}}$, C being assumed as 400 millimetres. The polar co-ordinates, r, θ, thus found, were then converted into rectangular co-ordinates by the usual formulæ, $x = r\cos\theta$, $y = r\sin\theta$. The results thus found are shown in the following table:—

β DELPHINI.

Interpolated Angles and Epochs.

θ	t	Δt	$\frac{\Delta t}{\Delta\theta}$	$r = 400\sqrt{\frac{\Delta t}{\Delta\theta}}$	$x = r\cos\theta$	$y = r\sin\theta$
15°	1874·78					
		0·83				
20	1874·61		0·149	154·40	145·07	52·80
		0·66				
25	1875·27					
		0·56				
30	1876·83		0·104	128·96	111·68	64·48
		0·48				
35	1877·31					
		0·39				
40	1877·70		0·071	106·40	81·50	68·30
		0·32				
45	1878·02					
		0·27				
50	1878·29		0·050	89·44	57·48	68·51
		0·23				
55	1878·52					
		0·20				
60	1878·72		0·039	79·00	39·50	68·41
		0·19				
65	1878·91					
		0·17				
70	1879·08		0·032	71·60	24·48	67·23
		0·15				
75	1879·23					
		0·14				
80	1879·37		0·028	66·92	11·61	65·90
		0·14				
85	1879·51					
		0·14				
90	1879·65		0·027	65·60	—	65·60
		0·13				
95	1879·78					
		0·13				
100	1879·91		0·026	64·00	11·11	63·02
		0·13				
105	1880·04					
		0·13				
110	1880·17		0·027	65·60	22·43	61·59
		0·14				
115	1880·31					
		0·14				
120	1880·45		0·029	68·00	34·00	58·88
		0·15				

β DELPHINI.

Interpolated Angles and Epochs—*continued.*

θ	t	Δt	$\frac{\Delta t}{\Delta \theta}$	$r = 400\sqrt{\frac{\Delta t}{\Delta \theta}}$	$x = r\cos\theta$	$y = r\sin\theta$
125	1880·60					
		0·15				
130	1880·75		0·031	70·40	45·19	53·92
		0·16				
135	1880·91					
		0·17				
140	1881·08		0·036	75·88	58·12	48.76
		0·19				
145	1881·27					
		0·21				
150	1881·48		0·044	83·88	72·64	41·94
		0·23				
155	1831·71					
		0·25				
160	1881·96		0·054	92·92	87·25	31·77
		0·29				
165	1882·25					
		0·33				
170	1882·58		0·069	105·04	103·35	18·23
		0·36				
175	1882·94					
		0·39				
180	1883·33		0·082	114·40	114·40	—
		0·43				
185	1883·76					
		0·43				
190	1884·19		0·087	118·00	116·20	20·48
		0·44				
195	1884·63					
		0·40				
200	1885·03					

These values of x and y having been plotted on the millimetre paper, taking the position of the principal star as the origin of co-ordinates, it was found possible to describe an ellipse nearly through them. This is the apparent ellipse. Its centre being then joined with the origin of co-ordinates—which is the *projection* of the focus of the real ellipse—and produced both ways, gave the projection of the major axis of the real ellipse, and the position of the periastron and apoastron on the apparent orbit. The ratio of the distance from the centre to the principal star, and the distance from the centre to the periastron, gave the eccentricity of the real ellipse, which was found to be 0·337. The harmonic ellipse was then drawn by computing harmonic means between the intercepts in the apparent ellipse on the axes of x and y, and other chords drawn through the origin. The ratios of the minor to the major axis of this ellipse then gave the cosine of the angle of eccentricity, or the angle of inclination of the real orbit, which came out 59° 20′. The position angle of the major axis of the harmonic ellipse was found to be 2° 38′, which is the direction of the line of nodes. A chord drawn in the apparent ellipse through the origin, and bisected at the origin, gave the projection of the *latus rectum* of the real ellipse. Lines were then drawn through the centre of the apparent ellipse parallel to the axis of the harmonic ellipse, and having the same ratio, and an ellipse described with these axes gave the projection of the auxiliary circle. A line was then drawn through the centre C of the apparent ellipse parallel to the projection of the *latus rectum*, and from the points T, T', where this line met the auxiliary ellipse, lines were drawn parallel to the projection of the major axis, and lengths laid off on each side $= \frac{1}{2}\pi \cdot CN$, N being the projection of the periastron. These lines were then divided into nine equal parts, and ordinates laid off from the projection of the major axis on each side, equal to $CT \sin 10°$, $CT \sin 20°$, $CT \sin 30°$, &c.

The points thus found give an ephemeris curve (the projection of the so-called curve of sines), and from this curve the period was computed in the usual way. This came out 30·91 years, and the epoch of periastron was found from the interpolating curve to be 1882·25.

The position of the periastron, λ, was found by the usual formula,

$$\tan \lambda = \tan (\lambda' - \Omega) \sec \gamma,$$

where λ' is the angle between the projection of the major axis and the initial line through the origin, Ω the position of the node, and γ the inclination of the orbit.

This gives

$$\tan \lambda = \tan (-15° \, 12' - 2° \, 38') \sec 59° \, 20' ;$$

whence

$$\lambda = -32° \, 14', \text{ or } 360° - 32·14 = 327° \, 46'.$$

By drawing an interpolating curve for the observed distances, and then comparing the distances thus found with the distances measured at corresponding points in the apparent orbit, the value of a millimetre in the assumed scale was found to be $0''\cdot00309$.

The actual length of the semi-axis major of the harmonic ellipse was found to be 148·3 millimetres, and as this is equal to the *semi-latus rectum* of the real ellipse, we have

$$\text{semi-axis major of real ellipse} = a = \frac{l}{1-e^2};$$

or

$$a = \frac{148\cdot3}{1-(0\cdot337)^2} \times 0''\cdot00309;$$

or

$$a = 0''\cdot516957.$$

Hence we have the following elements of β Delphini :—

Position of Node, . . .	$\Omega = 2^\circ\ 38'$ (1880).
Inclination, ...	$\gamma = 59^\circ\ 20'$.
Position of periastron, . .	$\lambda = 327^\circ\ 46'$.
Eccentricity, ...	$e = 0\cdot337$.
Period in years, . . .	$P = 30\cdot91$.
Periastron passage, A. D., . .	$T = 1882\cdot25$.
Semi-axis major, . . .	$a = 0''\cdot517$.
Mean annual motion, . .	$\mu = +\ 11^\circ\cdot64$.

These elements are of course only provisional, and further observations will be required before an accurate computation of the orbit can be made.

For the calculation of an ephemeris, the following formulæ are derived from the elements :—

$$(1)\quad u - 19^\circ\cdot308 \sin u = 11^\circ\cdot64\,(t - 1882\cdot25);$$

$$(2)\quad \tan \tfrac{1}{2} V = 1\cdot42 \tan \tfrac{1}{2} u;$$

$$(3)\quad \tan(\theta_e - 2^\circ\ 38') = 0\cdot51 \tan(V + 327^\circ\ 46');$$

$$(4)\quad \rho = 0''\cdot517\,(1 - 0\cdot337 \cos u).\ \frac{\cos(V + 327^\circ\cdot46')}{\cos(\theta - 2^\circ\ 38')};$$

where u is the eccentric anomaly, V the true anomaly for the time t, θ the required position angle, and ρ the distance.

By means of these formulæ I have computed the position angles and distances at the different epochs of observation, and the following is a comparison between the observed and computed places :—

Epoch.	θ_0	θ_c	$\theta_0 - \theta_c$	ρ_0	ρ_c	$\rho_0 - \rho_c$	Remarks.
1874·66	15·6	14·8	+ 0·8	0·61	0·53	+ 0·08	$\theta_0 = \{$ observed angle.
1874·80	15·1	15·6	− 0·5	0·4 ±	0·52	− 0·12	$\theta_c = \{$ computed angle.
1875·65	20·1	20·7	− 0·6	0·54	0·47	+ 0·07	$\rho_0 = \{$ observed distance.
1876·66	25·8	28·5	− 2·7	0·48	0·40	+ 0·08	$\rho_c = \{$ computed distance.
1877·79	40·8	41·9	− 1·1	0·32	0·31	+ 0·01	
1878·65	53·7	58·6	− 4·9	0·24	0·24	0·00	
1878·70	59·2	59·7	− 0·5	oblong.	0·24	—	
1880·68	133·6	128·4	+ 5·2	0·26	0·21	+ 0·05	
1881·50	149·2	150·6	− 1·4	0·26	0·27	− 0·01	
1882·60	167·5	170·1	− 2·6	0·26	0·32	− 0·06	
1883·25	183·90	178·5	+ 5·4	0·194	0·348	− 0·154	
1883·55	182·50	182·3	+ 0·2	0·23	0·35	− 0·12	
1884·71	197·75	195·5	+ 2·25	0·32	0·36	− 0·04	

The agreement is a tolerably close one, if we consider what a close and difficult object the star is to measure. Burnham's measures near the epoch 1880·68 vary from 127°·1 to 139°·5; and near the epoch 1882·60, from 161°·0 to 174°·6. The measured distance, 0″·194, at the epoch 1883·25, is evidently too small. I find that the stars were at their minimum distance, 0″·192, at the epoch 1879·91; and in this year Burnham failed to elongate the star with the 18½-inch refractor of the Dearborn Observatory, U. S. A.

After completing the above calculations, I learned that the orbit had been previously computed by Doubiago. The following are his elements, which are given for comparison.

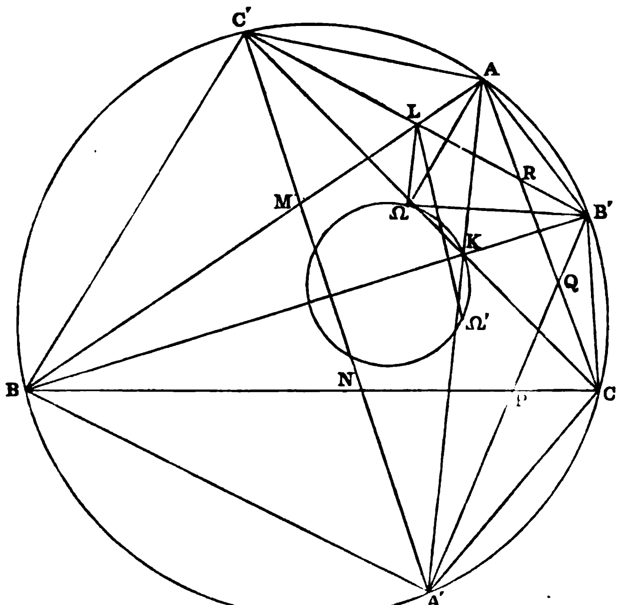
Doubiago's Elements of β Delphini.

a = 0″·55.
Ω = 163° 34′.
γ = 54° 54′
λ = 354° 36′.
e = 0·3567.
P = 26·07.
T = 1882·19.

XXX.—ON THE HARMONIC HEXAGON OF A TRIANGLE. By JOHN CASEY, LLD., F.R.S.

[Read, January 26, 1886.]

DEFINITION I.—If ABC be any triangle; AA', BB', CC' its symmedian lines, produced to meet its circumcircle in the points A', B', C', the hexagon, whose vertices are the six points A, B', C, A', B, C', possessing several geometrical properties, it is convenient to have a definite name for it. I propose to call it the *harmonic hexagon* of the triangle.



DEFINITION II.—Two triangles, having the same symmedian lines, are called *cosymmedians*.

DEFINITION III.—The lines AA', BB', CC' are called *the symmedian lines of the hexagon.*

PROPOSITION I.—*The triangles ABC, $A'B'C'$ are cosymmedians.* (Fig. 1).

Dem.—Since the three lines AA', BB', CC' are concurrent, the six points in which they intersect the circle are in involution. Hence the anharmonic ratio of the four points B, A, C, A' is equal to the anharmonic ratio of their four conjugates B', A', C', A; but since AA' is a symmedian of the triangle ABC, the four points B, A, C, A' form a harmonic system. Hence the four points B', A', C', A form a harmonic system. Therefore AA' is a symmedian of the triangle $A'B'C'$. Similarly, BB', CC' are symmedians, and therefore the triangles are cosymmedians.

Proposition II.—*If two triangles be cosymmedians, the sides of one are proportional to the medians of the other.*

Dem.—The angle $B'A'C'$ is equal to the sum of the angles $B'A'A$, $AA'C'$; that is, equal to the sum of $B'BA$, ACC'; and these angles are, respectively, equal to the angles which the medians from B and C of the triangle ABC make with BC. Hence, if G be the centroid of ABC, the angle BAC is the supplement of BGC; and therefore the angles of the triangle $A'B'C'$ are equal to the angles of a triangle whose sides are the medians of ABC. Hence the proposition is proved.

Proposition III.—*Lemoine's First Circles of two cosymmedian triangles are identical.*

Dem.—Let O be the common circumcentre of the triangles; R its radius; ρ, ρ_1, the radii of their first Lemoine Circles; then, by a well-known property of these circles,

$$3\rho^2 = R^2 - \left(\frac{OK}{2}\right)^2 = 3\rho_1^2.$$

Hence $\rho = \rho_1$; and since the middle point of OK is the centre of each, the circles are identical.

Cor. 1.—*Lemoine's Second Circles of two cosymmedian triangles are identical.*

For if ρ', ρ_1' denote the radii of their Lemoine's second circles, we have

$$\rho'^2 = \rho^2 - \left(\frac{OK}{2}\right)^2 = \rho_1'^2. \quad \text{Hence } \rho' = \rho_1'.$$

Cor. 2.—*The Brocard angles of two cosymmedian triangles are equal.*

For if the Brocard angles be ω, ω', we have

$$1 - 3\tan^2\omega = \frac{OK^2}{R^2} = 1 - 3\tan^2\omega'. \quad \text{Hence } \omega = \omega'.$$

Cor. 3.—*The Brocard points of a triangle are also the Brocard points of its cosymmedian.*

Let Ω, Ω' be the Brocard points of ABC; then the angle $\Omega O K = \omega = \omega'$. Hence Ω is a Brocard point of the triangle $A'B'C'$.

Cor. 4.—If x, y, z; x', y', z' be the perpendiculars let fall from their common symmedian point on the sides of the two cosymmedian triangles ABC, $A'B'C'$;

then
$$\frac{x}{a} = \frac{x'}{a'} = \frac{y}{b} = \frac{y'}{b'} = \frac{z}{c} = \frac{z'}{c'}.$$

For
$$\frac{x}{a} = 2 \tan \omega, \quad \frac{x'}{a'} = 2 \tan \omega'. \quad \text{Hence } \frac{x}{a} = \frac{x'}{a'}.$$

PROPOSITION IV.—*If the circumcircle of two cosymmedian triangles be inverted from any arbitrary point, the inverses of their six vertices will be the vertices of two other cosymmedian triangles.*

Dem.—Let the points inverse to A, B, C; A', B', C', respectively, be A_1, B_1, C_1; A_1', B_1', C_1'. Now since the anharmonic ratio of any four concyclic points is equal to the anharmonic ratio of the four points inverse to them (*Sequel*, Book VI., Sect. IV., Prop. 8); the four points B_1, A_1, C_1, A_1' form a harmonic system. Hence A_1A_1' is a symmedian of the triangle $A_1B_1C_1$, and the proposition is proved.

Cor. 1.—The circumcircle of two cosymmedian triangles can be inverted, so that the points inverse to their vertices will be the vertices of two equilateral triangles.

For if the inverses of A, B, C be the vertices of an equilateral triangle, the inverses of A', B', C' will evidently be the vertices of another; but if the centre of inversion be either of the two points common to two of the Apollonian circles of the triangle ABC, it will invert into an equilateral triangle. Hence the proposition is proved.

Cor. 2.—When two cosymmedian triangles invert into two equilateral triangles, the harmonic hexagon inverts into a regular hexagon.

Cor. 3.—The inverse of the angular points of a harmonic hexagon from any arbitrary point are the angular points of another harmonic hexagon.

PROPOSITION V.—*The anharmonic ratio of any four consecutive vertices of a harmonic hexagon is constant.*

Dem.—The anharmonic ratio is equal to that of four consecutive vertices of a regular hexagon, which is constant.

Cor. 1.—Any side of a triangle is divided in a given anharmonic ratio by the two non-corresponding sides of its cosymmedian.

For consider the line AB; the anharmonic ratio of the four points $ALMB$ is equal to the pencil $(C'.AB'A'B)$, which is given, being equal to that of a corresponding pencil for a regular hexagon.

Cor. 2.—The rectangle contained by the six sides of two cosymmedian triangles is equal to 27 times the continued product of the sides of the harmonic hexagon.

Dem.—The anharmonic ratio of the four points A, B', C, A' is equal to that of corresponding points of a regular hexagon. Hence $AC.B'A' = 3.AB'.CA'$; and, multiplying these and two other corresponding equations, the proposition is proved.

Cor. 3.—The continued product of the three symmedian lines of a harmonic hexagon is equal to eight times the continued product of three alternate sides of the hexagon.

Proposition VI.—*If the points of intersection of the sides of two cosymmedian triangles ABC, $A'B'C'$ be denoted by L, M, N, P, Q, R; then the Brocard points of the triangles are isogonal conjugates, with respect to the angles of intersection L, M, N, P, Q, R.*

Dem.—Join ΩA, $\Omega B'$, $\Omega' B$, $\Omega' C$. Now the angle ΩAB is equal to the angle $\Omega B'C'$, being, respectively, the Brocard angles of the triangles ABC, $A'B'C'$. Hence the four points A, L, Ω, B' are concyclic. Hence the angle $\Omega LB'$ is equal to $\Omega AB'$. In like manner, the angle $\Omega' LB = \Omega' C'B$. But since the angles BCB', BAB' are equal and the angles $\Omega' C'B'$ and $LA\Omega$ are Brocard angles, the angles $\Omega' C'B$, $\Omega AB'$ are equal; hence the angles $\Omega' LB$ and $B'L\Omega$ are equal. Hence the proposition is proved.

Cor. 1.—The six angles of intersection of the sides of the triangles ABC, $A'B'C'$, at the points L, M, N, P, Q, R, are equal, respectively, to those subtended at either Brocard point by the six sides of the harmonic hexagon.

For, since the points A, L, Ω, B are concyclic, the angle $ALB' = A\Omega B'$.

Cor. 2.—The angle subtended at Ω by the three alternate sides BC', AB', CA' of the harmonic hexagon are, respectively, equal to those subtended at Ω' by the same side, taken in the order CA', BC', AB'; and, similarly, for the other three sides.

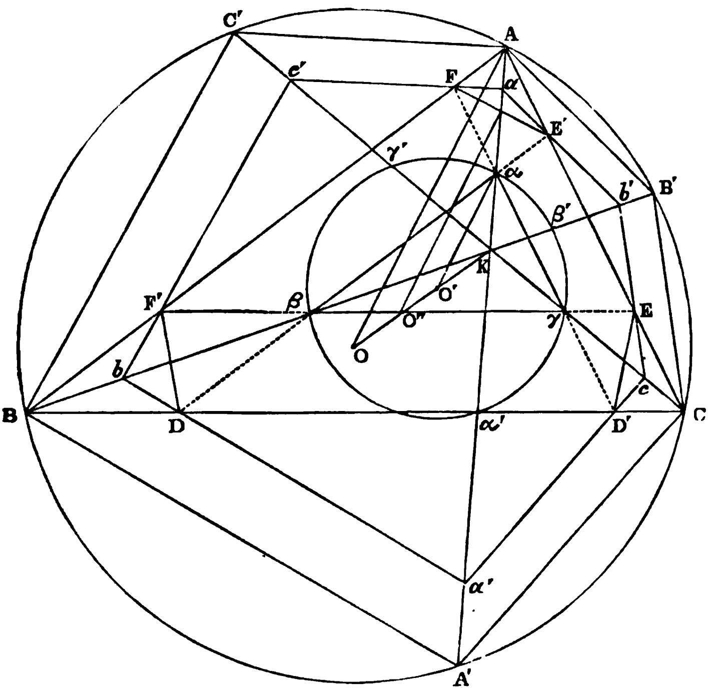
Cor. 3.—The feet of the perpendiculars, let fall from the points Ω, Ω' on the sides of the two cosymmedian triangles ABC, $A'B'C'$, are concyclic.

Cor. 4.—If R' be the radius of the circle of *Cor.* 3, $R' = R \sin \omega$.

Proposition VII.—*If in any triangle ABC a triangle similar to its cosymmedian be inscribed, the centre of similitude of the inscribed triangles is the symmedian point of the original triangle ABC.*

Dem.—Let K be the symmedian point; then the angle BKC is equal to the sum of the angles BAC, ABK, KCA; that is, equal to the sum of the angles BAC, $B'A'A$, $AA'C'$; or the sum of BAC, $B'A'C'$. Hence (*Sequel*, Book III. Prop. 17) the propositon is proved.

PROPOSITION VIII.—*If K be the centre of similitude of the triangle ABC* (Fig. 2), *and a homothetic triangle $\alpha\beta\gamma$, the circumcircle of the triangle $\alpha\beta\gamma$ will meet the symmedian lines AA', BB', CC' in three new points α' β' γ', which will be the vertices of a triangle homothetic with the cosymmedian of the triangle ABC.*



Dem.—Since K is the homothetic centre of the triangles ABC, $\alpha\beta\gamma$, it is the centre of similitude of their circumcircles. Hence the lines KA', KB', KC' are divided proportionally in the points α', β', γ'; and therefore the triangles $A'B'C'$, $\alpha'\beta'\gamma'$ are homothetic. Hence the proposition is proved.

Cor. 1.—The triangles $\alpha\beta\gamma$, $\alpha'\beta'\gamma'$ are cosymmedians.

Cor. 2.—If the sides of the triangle $\alpha\beta\gamma$ produced, if necessary, meet those of ABC in six points; and the sides of $\alpha'\beta'\gamma'$ meet the sides of $A'B'C'$ in six other points, the twelve points are concyclic.

Dem.—The first six points lie on a Tucker's circle of the triangle ABC, and the other six on a corresponding Tucker's circle of $A'B'C'$; and the proposition will be proved by showing that these circles are identical.

Let $\alpha\beta$ meet AC in E', and $\alpha\gamma$ meet AB in F, and α'' be the middle point of FE'; and O, O' the circumcentres of ABC, $\alpha\beta\gamma$. Through α'' draw $\alpha''O''$ parallel to AO; then O'' will be the middle point of OO', and will be the centre of the Tucker's circle of ABC. Now let R, R' be the circumradii of the triangles ABC, $\alpha\beta\gamma$; then we have

$$\alpha''O'' = \frac{R + R'}{2}.$$

Also, if ρ_1 denote the radius of Lemoine's second circle of the triangle ABC, we have

$$\rho_1 : F\alpha'' :: KA : \alpha''A :: R : \tfrac{1}{2}(R - R'); \text{ hence}$$

$$F\alpha'' = \rho_1 \left(\frac{R - R'}{2R}\right).$$

Hence the square of the radius of the Tucker's circle of the triangle ABC is equal to

$$\left(\frac{R + R'}{2}\right)^2 + \rho_1^2 \left(\frac{R - R'}{2R}\right)^2;$$

and it can be shown that the square of the radius of the corresponding Tucker's circle of the triangle $A'B'C'$ is the same, and they have the same centre. Hence they coincide. Q.E.D.

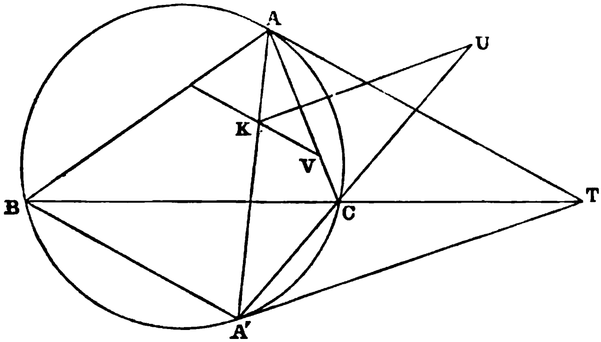
Proposition IX.—*If the sides of the triangle $\alpha\beta\gamma$ meet the sides of ABC in the points D, D'; E, E'; F, F', the three triangles AFE', $DF'B$, $D'CE$ are directly similar. Their invariable points are the centroids of these triangles, and their double points are the other points of intersection of the circle through the invariable points with the symmedians of the triangle ABC.*

For if a, b, c be the centroids of the triangles AFE', $DF'B$, $D'CE$; join aF, bF', and produce them to meet c'; and since a is the centroid of AFE', the angle KaF is the angle between two medians of AFE'; but AFE' is similar to ABC. Hence KaF is equal to the angle between two medians of ABC, and therefore equal to an angle of the cosymmedian triangle $A'B'C'$, which is easily seen to be $A'B'C'$; therefore KaF is equal to $A'AC'$. Hence aF is parallel to AC'. Similarly bF' is parallel to BC. Therefore the figures $KAC'B$, $Kac'b$ are homothetic. Hence the point c' is on the line KC'; and it is evident that the figures $c'FAE'$, $c'F'DB$ are directly similar. Hence c' is a double point. Similarly a', b' are double points, and it is easy to see that a, b, c are the invariable points.

Cor. 1.—If we make a corresponding construction for the triangles $\alpha'\beta'\gamma'$, $A'B'C'$, we shall find that for the new system of three figures directly similar, a, b, c are the double points; and a', b', c' the invariable points. Hence the two systems are so related, that the double points of either system are the invariable points of the other.

Cor. 2.—The triangles abc, $a'b'c'$ are cosymmedians.

PROPOSITION X.—*If through the symmedian point of a harmonic hexagon parallels be drawn to the tangents at its vertices; then taking the points in which each parallel meets the sides of the hexagon passing through the corresponding vertex, the twelve points of intersection are concyclic.*



Dem.—Let K be the symmedian point of the triangle ABC; then BA', $A'C$ are two sides of the harmonic hexagon. Through K draw KU parallel to $A'T$, then U will be one of the twelve points of intersection. Draw KV parallel to AT. Now the angle $AUK = TA'U = A'AV$. Similarly the angle $AVK = KA'U$. Hence the triangles AKV, UKA' are equiangular. Hence $KU.KV = AK.KA'$. Now KV is the radius of the second Lemoine circle, both for the triangle ABC and its cosymmedian. Hence KU has the same value for each of the twelve points of intersection, and therefore the twelve intersections are concyclic.

DEF.—*We shall, from its analogy to the case of the triangle, call the circle through these twelve points Lemoine's second hexagon circle.*

Cor. 1.—The intercepts which Lemoine's second hexagon circle make on the sides of the hexagon are proportional to the cosines of the angles which these sides subtend in the circumcircle. Hence it may be called the cosine circle of the hexagon.

Cor. 2.—If the sides of the harmonic hexagon $\alpha\beta'\gamma\alpha'\beta\gamma'$ (see fig., Prop. VIII.), be produced to meet the sides of $AB'CA'BC'$, viz., each side of the former intersecting the two sides adjacent to the side parallel to it in the latter, the twelve points of intersection are concyclic.

If R, R' be the circumradii of the hexagon $AB'CA'BC'$, $\alpha\beta'\gamma\alpha'\beta\gamma'$, and R'' the radius of the cosine circle of $AB'CA'BC'$; then it may be proved, as Prop. VIII. *Cor.* 2, that the twelve points of intersection lie on a circle, the square of whose radius is

$$\left(\frac{R+R'}{2}\right)^2 + R''^2\left(\frac{R-R'}{2R}\right)^2.$$

Cor. 3.—When the hexagon $\alpha\beta'\gamma\alpha'\beta\gamma'$ reduces to a point, the circle of *Cor.* 2 will be called, from analogy, Lemoine's first circle of the hexagon; its radius squared is equal to

$$\frac{R^2 + R'^2}{4}.$$

Proposition XI.—*The perpendiculars from the symmedian point of a harmonic hexagon, on the sides of the hexagon, are proportional to the sides.*

Dem.—The perpendiculars from K on the lines $C'A$, AB' (fig., Prop. viii.), are in the ratio of $\sin C'AK : \sin KAB'$; that is, as $\sin C'AA' : \sin A'AB'$ or $:: C'A' : A'B'$; but $C'A' : A'B' :: C'A : AB'$, since the points C', A', B', A' form a harmonic system. Hence the perpendiculars from K on the lines $C'A$, AB' are proportional to these lines, &c. Hence the proposition is proved.

Definition I.—If O be the circumcentre of the hexagon, the circle on OK as diameter is called the Brocard circle of the hexagon.

Definition II.—If the sides of the harmonic hexagon be denoted by a, b, c, d, e, f, and the perpendiculars from K on three sides by x, y, z, u, v, w; then the auxiliary angle Θ determined by any of the equations $x = \frac{1}{2} a \tan\Theta$, $y = \frac{1}{2} b \tan\Theta$, &c., is called the Brocard angle of the hexagon.

Cor.—The radius of the cosine circle of the hexagon is equal to $R \tan\Theta$.

For, let fall the perpendicular KX on $A'C$ (see fig., Prop. x.); then

$$KX \div KU = \sin U = \sin A'AC = A'C \div 2R.$$

Hence

$$KU \div 2R = KX \div A'C = \tfrac{1}{2} \tan\Theta;$$

therefore

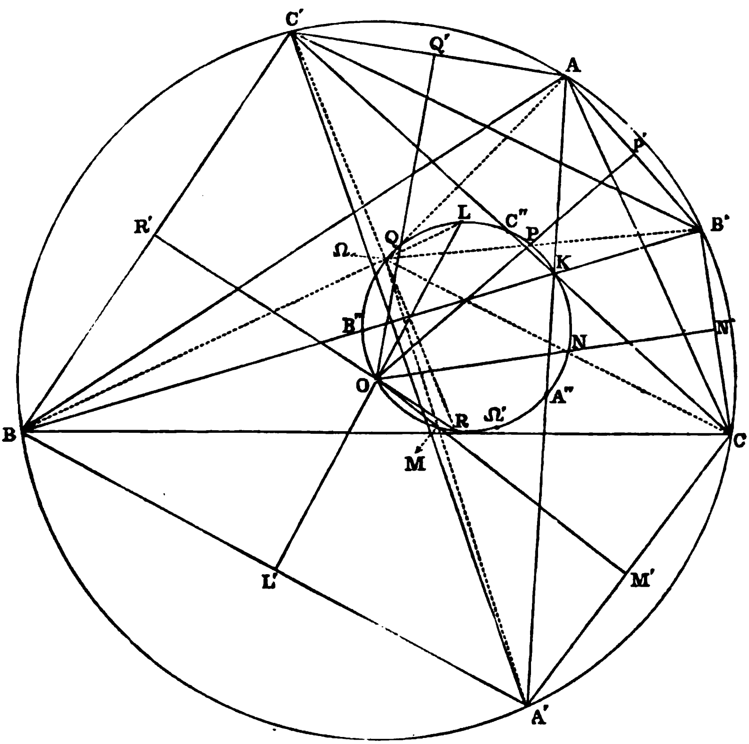
$$KU = R \tan\Theta.$$

Proposition XII.—*The perpendiculars from the centre of the circumcircle on the sides of a harmonic hexagon meet its Brocard circle in six points, which connect concurrently in two ways with the vertices of the hexagon.*

Dem.—Let the points (Fig. 4) of intersection of the perpendicular with the Brocard circle be L, M, N, P, Q, R. Join KL, KM; then because the angle KLO is right, KL is parallel to BA'. Hence LL' is equal to the perpendicular from K on BA. Similarly, $M'M'$ is equal to the perpendicular from K on $A'C$. Hence (Prop. xi.) $LL' : MM' :: BL' : A'M'$. Hence the triangles $BL'L$, $A'M'M$ are equiangular; therefore the angle BLL' is equal to $A'MM'$. Hence, if the lines BL and $A'M$ intersect in Ω, the four points O, M, L, Ω are concyclic; there-

fore Ω is a point on the Brocard circle. Similarly the lines CN, $B'P$, AQ, $C'R$ each intersect BL on the Brocard circle, and therefore each passes through Ω. In the same manner it may be shown that the six lines $A'L$, CM, $B'N$, AP, $C'Q$, BR are concurrent, and meet in another point Ω' on the Brocard circle.

DEF.—Ω, Ω' are called the Brocard points; and L, M, N, P, Q, R the invariable points of the hexagon.



Cor. 1.—Ω, Ω' are isogonal conjugates with respect to each angle of the harmonic hexagon $AB'CA'BC'$.

For the angles $A'B\Omega$, $C'B\Omega'$ are each equal to the Brocard angle of the hexagon. Hence, &c.

Cor. 2.—The feet of the perpendiculars from Ω, Ω' on the sides of the hexagon are concyclic.

Cor. 3.—If ω be the Brocard angle of the triangle ABC, and Θ the Brocard angle of the hexagon, $\tan\Theta = 3\tan\omega$.

Dem.—2 tan $\Theta = LL' \div A'B$ = perpendicular from K on $A'B \div A'B$; and 2 tan ω = perpendicular from K on $BC \div BC'$. Hence

$$\frac{\tan\Theta}{\tan\omega} = \frac{\text{perp. from } K \text{ on } A'B}{\text{perp. from } K \text{ on } BC} \times \frac{BC}{A'B}$$

$$= \frac{\sin A'BK}{\sin CBK} \times \frac{BC}{A'B} = \frac{A'B'}{B'C} \times \frac{BC}{A'B};$$

that is, equal to the anharmonic ratio of the four points B, A', C, B', and therefore equal to the anharmonic ratio of the corresponding points in a regular hexagon, and therefore equal to 3. Hence tan Θ = 3 tan ω.

Proposition XIII.—*If figures directly similar be described on the sides of the harmonic hexagon, the middle points of its symmedian lines AA', BB', CC' are each a double point for three pairs of figures.*

Dem.—Let A'' be the middle point of AA'; then it may be proved, as in *Conics*, page 247, that A'' is the double point of the figures on $C'A$, AB'; and also of the figures described on BA', $A'C$; and it remains to be proved that it is a double point of the figures described on BC', $B'C$. Join BA'', $A''C$; $C'A''$, $A''B$; then, since A'' is a double point of the figures $C'A$, AB', we have $C'A'' : A''A :: A''A : A''B'$. Hence $C'A'' . A''B' = A''A^2$. Similarly $BA'' . A''C = A''A'^2$. Hence $BA'' . A''C = C'A'' . A''B'$; and the angles $BA''C'$, $B'A''C$ are equal. Hence the triangles $BA''C'$, $B'A''C$ are equiangular, and they are directly similar. Hence the proposition is proved.

Cor. 1.—The four points B, C', K, A'' are concyclic.

Cor. 2.—If figures directly similar be described on the six sides of the harmonic hexagon $AB'CA'BC'$, the symmedian lines of the harmonic hexagon, formed by any six corresponding lines, pass respectively through the middle points A'', B'', C'' of the symmedian lines of $AB'CA'BC'$.

Cor. 3.—In the same case, the locus of the symmedian point of the hexagon, formed by six corresponding lines of these figures, is the Brocard circle of the original hexagon.

Cor. 4.—The centre of similitude of any two hexagons, each formed by six corresponding lines of figures directly similar described on the sides of $AB'CA'BC'$, is a point on its Brocard circle.

Cors. 2, 3, 4 may be proved exactly as in the corresponding cases for triangles (see *Conics*, page 248).

Cor. 5.—The six lines joining, respectively, the invariable points L, M, N, P, Q, R to six corresponding points are concurrent. The locus of their point of concurrence is the Brocard circle of $AB'CA'BC'$, and they form a pencil in involution.

Proposition XIV.—*The triangle formed by three alternate sides of the harmonic hexagon is in perspective with the triangle formed by the three invariable points corresponding to the three remaining sides.*

Dem.—Let us consider the triangle formed by the three sides BC', AB', CA'. Let them meet in the points A''', C''', B'''; it is required to prove that the triangle $A'''B'''C'''$ is in perspective with the triangle NLQ, formed by the invariable points corresponding to the sides $B'C$, $A'B$, $C'A$. Join the points N, L, Q, respectively, to K, and produce to meet the sides BC', AB', CA'. They will meet them in points where the same sides are intersected by Lemoine's first hexagon circle; and since Lemoine's first circle and the Brocard circle are concentric, the parts intercepted by them on the line KN will be equal. Hence the lines $A'''N$, $A'''K$ are isotomic conjugates with respect to the angle A'''. Similarly, $B'''Q$, $B'''K$ are isotomic conjugates with respect to the angle B'''; and $C'''L$, $C'''K$ with respect to the angle C'''. Hence the lines $A'''N$, $B'''Q$, $C'''L$ are concurrent. Q.E.D.

NOTE ADDED IN THE PRESS.

Since writing the preceding Paper, I have succeeded in showing that the propositions contained in it are capable of remarkable extensions. I do this by proving that we can construct a harmonic polygon of any number of sides that is a cyclic polygon, having a point in its plane called its symmedian point, such that perpendiculars from it on the sides of the polygon are proportional to the sides. The solution of this problem is contained in the following theorem :—

The inverses of the angular points of a regular polygon of any number of sides form the angular points of a harmonic polygon of the same number of sides.

Dem.—Let A, B, C, &c., be the angular points of the original polygon; A', B', C' the points diametrically opposite to them. Now invert from any arbitrary point. The circumcircle of the original polygon will invert into a circle, and the lines AA', BB', CC', &c., into a coaxal system, and the radical axes of each circle of this system and the inverse of the circumcircle will be a concurrent system of lines (*Sequel*, Book VI., Sect. v., Prop. 4). Now if the inverses of the points A, B, C, &c.; A', B', C', &c., be a, β, γ, &c.; a', β', γ', &c.; the concurrent lines will be aa', $\beta\beta'$, $\gamma\gamma'$, &c., respectively; let K be their point of intersection. Now, since evidently the pionts A, B, C, B' form a harmonic system, the points a, β, γ, β' form a harmonic system. Hence the perpendiculars from the point K in $\beta\beta'$ on the lines $a\beta$, $\beta\gamma$ are proportional to these lines. Hence the proposition is proved.

It is evident now that the whole theory of Brocard circles, Brocard points, Lemoine circles, cosine circles, similar figures, invariable points, double points, &c., can be extended to harmonic polygons of any number of sides. The following are a few of the numerous

additional propositions that can be given in connexion with these polygons :—

1. If the alternate vertices 1, 3, 5 . . . $2n - 1$ of a harmonic polygon of $2n$ sides be joined, the lines of connexion form a harmonic polygon of n sides, and so also do the lines joining the remaining vertices 2, 4, 6 . . . $2n$.

2. If n be an odd number, the three polygons of Ex. 1 are cosymmedians.

3. If the symmedian lines AK, BK, CK, &c., of a harmonic polygon of an odd number of sides be produced to meet the circumcircle again in the points A', B', C', &c., the points A', B', C', &c., form the vertices of another harmonic polygon; and these two polygons are cosymmedian, and have the same Brocard angles, Brocard points, Lemoine circles, and cosine circles, &c.

4. The four symmedian chords of a harmonic octagon form a harmonic pencil.

5. The circles described through the extremities of the symmedian chords of a harmonic polygon, and intersecting the circumcircle orthogonally, are coaxal, and intersect each other at equal angles.

6. A harmonic polygon of any number of sides can be projected into a regular polygon of the same number of sides, and the projection of the symmedian point of the former will be the circumcentre of the latter.

7. The symmedian point of any harmonic polygon is the mean centre of the feet of the perpendiculars let fall from it on the sides of the polygon.

8. If Θ_n, Θ_{2n} be the Brocard angles of two harmonic polygons of n sides, and $2n$ sides, respectively; then

$$\tan \Theta_{2n} = 4 \cos^2 \frac{\pi}{2n} . \tan \Theta_n.$$

XXXI.—NOTES ON LAPLACE'S ANALYTICAL THEORY OF THE PERTURBATIONS OF JUPITER'S SATELLITES. By SIR ROBERT S. BALL, LL.D., F.R.S.

[Read, February 22, 1886.]

THE mathematical difficulties of that portion of the *Mécanique Celeste* which relates to the Perturbations of Jupiter's Satellites are well known. Any aid, however slight, towards the elucidation of the obscure points of Laplace's analysis may therefore be worthy of the attention of the Academy. The laborious Bowditch has not removed the difficulties I have felt.

In the present communication I have rewritten the theory of the perturbations in radius vector and longitude which are independent of the eccentricities and the inclinations. The results are those of Laplace, but the methods of demonstration have been modified.

I employ throughout the notation of Laplace as used in vol. iv. of the *Mécanique Celeste*. I commence with a theorem which Laplace does not use, though if he had done so the first part of his theory would have been greatly simplified. I find the theorem in *Pontécoulant*, vol. i., p. 511.

Let n be the real mean motion of the disturbed satellite.

a be the mean distance which in an undisturbed orbit would correspond to the mean motion n.

$a + \delta a + \delta r$ be the distance of a satellite from the centre of Jupiter, the periodic terms being represented by δr.

F be the portion of the disturbing function R which does not contain periodic terms.

Then the fundamental theorem is, that

$$\delta a = \frac{1}{3} a^3 \frac{dF}{da}.$$

For we have accurately

$$\frac{dv^2}{dt^2} = \frac{1}{r}\frac{d^2r}{dt^2} + \frac{\mu}{r^3} + \frac{1}{r} \cdot \frac{dR}{dr}.$$

Substitute for r its equivalent $a + \delta a + \delta r$ and

$$\frac{1}{r}\frac{d^2r}{dt^2} = \frac{1}{a}\frac{d^2\delta r}{dt^2},$$

$$\frac{\mu}{r^3} = \frac{\mu}{a^3}\left(1 - 3\frac{\delta a}{a} - 3\frac{\delta r}{a}\right),$$

$$\frac{1}{r}\frac{dR}{dr} = \frac{1}{a}\frac{dF}{da} + \frac{1}{a}\left(\frac{dR}{da} - \frac{dF}{da}\right);$$

whence, since $(\mu = n^2a^3)$,

$$\frac{dv^2}{dt^2} = n^2 \left| \begin{array}{l} 1 - 3\dfrac{\delta a}{a} + a^2\dfrac{dF}{da} \\ \qquad + \text{Periodic Terms.} \end{array} \right|.$$

Taking the square root

$$\frac{dv}{dt} = n \left| \begin{array}{l} 1 - \dfrac{3}{2}\dfrac{\delta a}{a} + \dfrac{a^2}{2}\dfrac{dF}{da} \\ \qquad + \text{Periodic Terms.} \end{array} \right|;$$

but if n be the real mean motion of the disturbed satellite, then

$$\frac{dv}{dt} = n + \text{Periodic Terms};$$

whence, finally,

$$\delta a = \frac{1}{3}a^3\frac{dF}{da}.$$

Perturbations in Radius Vector which are independent of the Eccentricities and Inclinations.

We first compute

$$2\int\frac{d(R)}{dt} + r\left(\frac{dR}{dr}\right). \qquad \text{(i)}$$

Omitting the inclinations, we have

$$R = \frac{m'r}{r'^2}\cos(v - v') - \frac{m'}{(r^2 - 2rr'\cos(v' - v) + r'^2)^{\frac{1}{2}}}$$

$$- \frac{S}{D} - \frac{Sr^2}{4D^3}(1 + 3\cos(2U - 2v))$$

$$- (\rho - \tfrac{1}{2}\phi)\frac{1}{3r^3}.$$

Jupiter's contribution to (i).

$$R = -(\rho - \tfrac{1}{2}\phi)\frac{1}{3r^3}.$$

$$2\int\frac{dR}{dt} = 2R.$$

$$r\frac{dR}{dt} = -3R.$$

$$2\int\frac{d(R)}{dt} + r\frac{dR}{dr} = \frac{1}{3r^3}(\rho - \tfrac{1}{2}\phi).$$

Let $$r = a + \delta a + \delta r,$$

and the expression becomes, retaining only periodic terms,

$$-\frac{1}{a^4}\left(\rho - \frac{\phi}{2}\right)\delta r.$$

Sun's contribution to (i).

$$R = -\frac{S}{D} - \frac{Sr^2}{4D^3} - \frac{3Sr^2}{4D^3}\cos(2U - 2v).$$

With Laplace's units we have $S \div D^3 = M^2$; and, neglecting the first term, which cannot contribute,

$$R = -\tfrac{1}{4}M^2r^2 - \tfrac{3}{4}M^2r^2\cos(2U - 2v),$$

$$2\int\frac{d(R)}{dt} = -\tfrac{1}{2}M^2r^2 - \frac{3n}{2n - 2M}M^2a^2\cos(2U - 2v),$$

$$r\left(\frac{dR}{dt}\right) = -\tfrac{1}{2}M^2r^2 - \tfrac{3}{2}M^2a^2\cos(2U - 2v).$$

Uniting, we have

$$-M^2r^2 - \frac{6n - 3M}{2n - 2M}M^2a^2\cos(2U - 2v);$$

whence, retaining the periodic terms only, we have

$$-2aM^2\delta r - \frac{6n - 3M}{2n - 2M}M^2a^2\cos(2U - 2v).$$

Each Satellite's contribution to (i).

$$R = \frac{m'r}{r'^2}\cos(v - v') - \frac{m'}{(r^2 - 2rr'\cos(v - v') + r'^2)^{\frac{1}{2}}}$$

$$= m'(\tfrac{1}{2}A_0 + A_1\cos(v - v') + A_2\cos(2v - 2v')).$$

First, consider the contribution of $\frac{1}{2}m'A_0$ to the periodic terms

$$2\int\frac{d(R)}{dt} = m'A_0,$$

$$r\frac{dR}{dt} = \tfrac{1}{2}m'r\frac{dA_0}{dr}.$$

Retaining the periodic terms, we have

$$\frac{m'}{2}\left(3\frac{dA_0}{da} + a\frac{d^2A_0}{da^2}\right)\delta r.$$

To find the contribution of

$$m'A_k\cos(kv - kv').$$

$$2\int\frac{d(R)}{dt} = m'\frac{2n}{n - n'}A_k\cos(kv - kv'),$$

$$r\frac{dR}{dr} = m'a\frac{dA_k}{da}\cos(kv - kv').$$

Uniting these terms, we have for each satellite's contribution to (i) (retaining of course only periodic terms),

$$\frac{m'}{2}\left(3\frac{dA_0}{da} + a\frac{d^2A_0}{da^2}\right)\delta r$$

$$+ m'\left(\frac{2n}{n - n'}A_1 + a\frac{dA_1}{da}\right)\cos(v - v')$$

$$+ m'\left(\frac{2n}{n - n'}A_2 + a\frac{dA_2}{da}\right)\cos(2v - 2v')$$

$$+ m'\left(\frac{2n}{n - n'}A_3 + a\frac{dA_3}{da}\right)\cos(3v - 3v').$$

We now substitute in the general formula

$$\frac{1}{2}\frac{d^2r^2}{dt^2} - \frac{\mu}{r} + 2\int\left(\frac{dR}{dt}\right) + r\left(\frac{dR}{dr}\right) \text{ const.},$$

retaining only periodic terms.

A delicate point has here to be carefully attended to. The left-hand of the equation will assume the form

$$\frac{d^2\Omega}{dt^2} + N^2\Omega = 0.$$

N must be very accurately determined to the second order. It is therefore necessary that the values of Ω in these two terms be absolutely equal. We have the term $\frac{1}{2}\frac{d^2r^2}{dt^2}$, where $r = a + \delta a + \delta r$; therefore

$$\frac{1}{2}\frac{d^2r^2}{dt^2} = \frac{d^2(a+\delta a)\delta r}{dt^2}.$$

Ω is therefore $(a + \delta a)\,\delta r$. If we had here omitted δa we should have altered N^2, which depends upon δa. This is the most critical point in the whole of this part of the analysis. The shortest method is as follows:—

$$\frac{d^2(a+\delta a)\delta r}{dt^2} + \frac{\mu}{(a+\delta a)^3}(a+\delta a)\,\delta r$$

$$+ a\delta r\,\Sigma m'\left(\frac{3}{2a}\frac{dA^{(0)}}{da} + \frac{1}{2}\frac{d^2A^{(0)}}{da^2}\right)$$

$$- \frac{1}{a^6}\left(\rho - \frac{\phi}{2}\right)\delta r$$

$$- 2aM^2\delta r$$

$$- \frac{6n - 3M}{2n - 2M}M^2a^2\cos(2U - 2v)$$

$$+ \Sigma m'\left(\frac{2n}{n-n'}A_k + a\frac{dA_k}{da}\right)\cos(hv - hv').$$

This may be written in the form

$$\frac{d^2(a+\delta a)\delta r}{dt^2}$$

$$+ (a + \delta a)\,\delta r \left[\frac{\mu}{(a+\delta a)^3} - \frac{1}{a^5}\left(\rho - \frac{\phi}{2}\right) - 2M^2 + 2M'\left(\frac{3}{2a}\frac{dA^{(0)}}{da} + \frac{1}{2}\frac{d^2A^{(0)}}{da^2}\right)\right]$$

$$- \frac{6n - 3M}{2n - 2M} M^2 a^2 \cos(2U - 2v)$$

$$+ \Sigma m'\left(\frac{2n}{n - n'} A^{(k)} + a\frac{dA^{(k)}}{da}\right)\cos(kv - kv').$$

To solve this, assume

$$(a + \delta a)\delta r = P\cos(2U - 2v) + \Sigma Q_{1,2}{}^{(k)}\cos(kv - kv'),$$

and put

$$N^2 = \frac{\mu}{(a+\delta a)^3} - \frac{1}{a^5}\left(\rho - \frac{\phi}{2}\right) - 2M^2 + \Sigma m'\left(\frac{3}{2a}\frac{dA^{(0)}}{da} + \frac{1}{2}\frac{d^2A^{(0)}}{da^2}\right),$$

whence, by substitution and identifying the coefficient of $\cos(2U - 2v)$ with zero,

$$- P(2M - 2n)^2 + PN^2 - \frac{6n - 3M}{2n - 2M} M^2 a^2;$$

whence

$$P = \frac{M^2}{N^2 - (2M - 2n)^2}\,\frac{6n - 3M}{2n - 2M} a^2;$$

but

$$N \mathrel{\triangle} n \quad \text{and} \quad \frac{M}{n} \mathrel{\triangle} 0;$$

whence

$$P \mathrel{\triangle} - \frac{M^2}{n^2} a^2.$$

Identifying the coefficient of $\cos(kv - kv')$ to zero,

$$- Q_{1,2}{}^{(k)}(kn - kn')^2 + N^2 Q_{1,2}{}^{(k)} + m'\left(\frac{2n}{n - n'} A^{(k)} + a\frac{dA^{(k)}}{da}\right) = 0,$$

or

$$Q_{1,2}{}^{(k)} = \frac{m'}{(kn - kn')^2 - N^2}\left(\frac{2n}{n - n'} A^{(k)} + a\frac{dA^{(k)}}{da}\right),$$

whence, finally, we have for δr (omitting $\delta a\,.\,\delta r$),

$$\delta r = - a\frac{M^2}{n^2}\cos(2U - 2v)$$

$$+\Sigma m'\left[\begin{array}{l}\dfrac{an^2}{(n-n')^2-N^2}\left(a^2\dfrac{dA^{(1)}}{da}+\dfrac{2n}{n-n'}\,aA^{(1)}\right)\cos(v-v'),\\[2ex] \dfrac{an^2}{(2n-2n')^2-N^2}\left(a^2\dfrac{dA^{(2)}}{da}+\dfrac{2n}{n-n'}\,aA^{(2)}\right)\cos(2v-2v'),\\[2ex] \dfrac{an^2}{(3n-3n')^2-N^2}\left(a^2\dfrac{dA^{(3)}}{da}+\dfrac{2n}{n-n'}\,aA^{(3)}\right)\cos(3v-3v').\end{array}\right.$$

It only remains to introduce the value of δa into N.

$$F=-\frac{1}{3a^3}\left(\rho-\frac{\phi}{2}\right)-\frac{1}{4}M^2a^2+\frac{1}{2}\Sigma m'A^{(0)},$$

$$\frac{dF}{da}=+\frac{1}{a^4}\left(\rho-\frac{\phi}{2}\right)-\frac{1}{2}M^2a+\frac{1}{2}\Sigma m'\frac{dA^{(0)}}{da},$$

whence,

$$\delta a=\frac{1}{3a}\left(\rho-\frac{\phi}{2}\right)-\frac{1}{6}a\frac{M^2}{n^2}+\frac{a^3}{6}\Sigma m'\frac{dA^{(0)}}{da};$$

but

$$N^2=\frac{\mu}{(a+\delta a)^3}-\frac{1}{a^5}\left(\rho-\frac{\phi}{2}\right)-2M^2+\Sigma m'\left(\frac{3}{2a}\frac{dA^{(0)}}{da}+\frac{1}{2}\frac{d^2A^{(0)}}{da^2}\right),$$

$$=n^2-3n^2\frac{\delta a}{a}-\frac{1}{a^5}\left(\rho-\frac{\phi}{2}\right)-2M^2+\Sigma m'\left(\frac{3}{2a}\frac{dA^{(0)}}{da}+\frac{1}{2}\frac{d^2A^{(0)}}{da^2}\right),$$

$$N^2=n^2\left(1-\frac{2}{a^3}\left(\rho-\frac{\phi}{2}\right)-\frac{3}{2}\frac{M^2}{n^2}+\Sigma m'a^2\left(\frac{dA^{(0)}}{da}+\frac{1}{2}a\frac{d^2A^{(0)}}{da^2}\right)\right).$$

This process appears to be free from the difficulties which beset Laplace's analysis.

On the Perturbations in the Longitudes of Jupiter's Satellites which are Independent of the Eccentricities and the Inclinations.

The following approximate method seems to have something to recommend it as regards directness and simplicity, when contrasted with the elaborate formulæ of Laplace :—

We have $$\frac{d}{dt}\left(r^2\frac{dv}{dt}\right)=-\frac{dR}{dv}.$$

Integrating, $$r^2 \frac{dv}{dt} = H - \int \frac{dR}{dv} dt,$$

$$\frac{dv}{dt} = \frac{H}{r^2} - \frac{1}{r^2} \int \frac{dR}{dv} dt.$$

Assume $$r = a + \delta a + \delta r,$$

$$\frac{dv}{dt} = \frac{H}{a^2}\left(1 - 2\frac{\delta a}{a}\right)$$

$$- 2\frac{H}{a^2}\frac{\delta r}{a} - \frac{1}{a^2}\int \frac{dR}{dv} dt.$$

Since the last line contains only periodic terms,

$$n = \frac{H}{a^2}\left(1 - 2\frac{\delta a}{a}\right);$$

whence, very nearly,

$$\frac{dv}{dt} = n - 2n\frac{\delta r}{a} - \frac{1}{a^2}\int \frac{dR}{dv} dt.$$

Taking only that portion of R which involves v, we have

$$R = -\frac{3}{4}M^2a^2\cos(2U-2v) + \Sigma m'\left(A^{(1)}\cos(v-v') + A^{(2)}\cos(2v-2v') + A^{(3)}\cos(3v-3v') + \&c.\right)$$

$$\frac{dR}{dv} = -\frac{3}{2}M^2a^2\sin(2U-2v) - \Sigma m'\left(A^{(1)}\sin(v-v') + A^{(2)}\sin(2v-2v') + 3A^{(3)}\sin(3v-3v') + \&c.\right)$$

$$\int\frac{dR}{dv}\,dt = -\frac{3}{4}\frac{M^2a^2}{n}\cos(2U-2v) + \Sigma m'\left(\frac{A^{(1)}}{n-n'}\cos(v-v') + \frac{2A^{(2)}}{2n-2n'}\cos(2v-2v') + \frac{2A^{(3)}}{3n-3n'}\cos(3v-3v') + \&c.\right)$$

$$-\frac{1}{a^2}\int\frac{dR}{dv}\,dt = +\frac{3}{4}\frac{M^2}{n}\cos(2U-2v) - \Sigma m'\left(\frac{1}{a^2}\frac{A^{(1)}}{n-n'}\cos(v-v') + \frac{1}{a^2}\frac{2A^{(2)}}{2n-2n'}\cos(2v-2v') + \frac{1}{a^2}\frac{3A^{(3)}}{3n-3n'}\cos(3v-3v') + \&c.\right)$$

$$-2n\frac{\delta r}{a} = 2\frac{M^2}{n}\cos(2U-2v) - \Sigma m' \left| \begin{array}{l} \dfrac{2n^3}{(n-n')^2-N^2}\left(a^2\dfrac{dA^{(1)}}{da} + \dfrac{2n}{n-n'}aA^{(1)}\right)\cos(v-v'), \\[2ex] \dfrac{2n^3}{(2n-2n')^2-N^2}\left(a^2\dfrac{dA^{(2)}}{da} + \dfrac{2n}{n-n'}aA^{(2)}\right)\cos(2v-2v'), \\[2ex] \dfrac{2n^3}{(3n-3n')^2-N^2}\left(a^2\dfrac{dA^{(3)}}{da} + \dfrac{2n}{n-n'}aA^{(3)}\right)\cos(3v-3v'). \end{array}\right.$$

Integrating,
$$r^2 \frac{dv}{dt} = H - \int \frac{dR}{dv}\, dt,$$

$$\frac{dv}{dt} = \frac{H}{r^2} - \frac{1}{r^2}\int \frac{dR}{dv}\, dt.$$

Assume
$$r = a + \delta a + \delta r,$$

$$\frac{dv}{dt} = \frac{H}{a^2}\left(1 - 2\frac{\delta a}{a}\right)$$

$$- 2\frac{H}{a^2}\frac{\delta r}{a} - \frac{1}{a^2}\int \frac{dR}{dv}\, dt.$$

Since the last line contains only periodic terms,

$$n = \frac{H}{a^2}\left(1 - 2\frac{\delta a}{a}\right);$$

whence, very nearly,

$$\frac{dv}{dt} = n - 2n\frac{\delta r}{a} - \frac{1}{a^2}\int \frac{dR}{dv}\, dt.$$

Taking only that portion of R which involves v, we have

$$R = -\frac{3}{4}M^2 a^2 \cos(2U - 2v) + \Sigma m'\left(A^{(1)}\cos(v - v') + A^{(2)}\cos(2v - 2v') + A^{(3)}\cos(3v - 3v') + \&c.\right)$$

$$\frac{dR}{dv} = -\frac{3}{2}M^2 a^2 \sin(2U - 2v) - \Sigma m'\left(A^{(1)}\sin(v - v') + A^{(2)}\sin(2v - 2v') + 3A^{(3)}\sin(3v - 3v') + \&c.\right)$$

$$\int \frac{dR}{dv}\,dt = -\frac{3}{4}\frac{M^2 a^2}{n}\cos(2U - 2v) + \Sigma m'\left(\frac{A^{(1)}}{n - n'}\cos(v - v') + \frac{2A^{(2)}}{2n - 2n'}\cos(2v - 2v') + \frac{2A^{(3)}}{3n - 3n'}\cos(3v - 3v') + \&c.\right)$$

$$-\frac{1}{a^2}\int \frac{dR}{dv}\,dt = +\frac{3}{4}\frac{M^2}{n}\cos(2U - 2v) - \Sigma m'\left(\frac{1}{a^2}\frac{A^{(1)}}{n - n'}\cos(v - v') + \frac{1}{a^2}\frac{2A^{(2)}}{2n - 2n'}\cos(2v - 2v') + \frac{1}{a^2}\frac{3A^{(3)}}{3n - 3n'}\cos(3v - 3v') + \&c.\right)$$

$$-2n\frac{\delta r}{a} = 2\frac{M^2}{n}\cos(2U - 2v) - \Sigma m' \left|\begin{array}{l} \dfrac{2n^3}{(n - n')^2 - N^2}\left(a^2\dfrac{dA^{(1)}}{da} + \dfrac{2n}{n - n'}aA^{(1)}\right)\cos(v - v'), \\[2ex] \dfrac{2n^3}{(2n - 2n')^2 - N^2}\left(a^2\dfrac{dA^{(2)}}{da} + \dfrac{2n}{n - n'}aA^{(2)}\right)\cos(2v - 2v'), \\[2ex] \dfrac{2n^3}{(3n - 3n')^2 - N^2}\left(a^2\dfrac{dA^{(3)}}{da} + \dfrac{2n}{n - n'}aA^{(3)}\right)\cos(3v - 3v'). \end{array}\right.$$

XXXII.—Further Report on the Flora of Southern Donegal.

By Henry Chichester Hart, B. A.

[Read, February 22, 1886.]

My explorations of 1885 were chiefly in south-west Donegal. The new ground I examined was that of the Boylagh barony, and from head-quarters at Glenties and Ardara. I also examined the limestone country[1] south of Brown Hall more carefully. My list of additions will show that it merited this attention. The most interesting piece of work was the finding a new site for several of our rarest alpine plants at Alt Mountain, south of Ardara. *Saxifraga aizoides*, *Thalictrum alpinum*, *Saussurea alpina*, and the parsley fern (*Cryptogramme crispa*), the last not before known in Donegal, grow here. I paid special attention to the pond-weeds, in which Donegal is rich, and I was rewarded by finding *P. prælongus*, *P. gramineus*, and *P. nitens*, all rarities in Ireland, and desiderata in Donegal. A more unexpected "find" was that of *Atropa belladonna*, looking as native as the most captious critic could desire; but, alas! forbidden by the iron laws of Geographical Distribution to be considered so. I visited Rathlin, O'Beirne's Island, the extreme west of the county, and numbered up about eighty-five species, none of which are in the least degree interesting. *Trifolium medium* and *Beta maritima* may, perhaps, be mentioned. This islet is storm-swept, and utterly devoid of shelter, being about two or three miles round, and about the same distance from the "Country," as the Tory Islanders call Ireland. We found storm-petrels' nests on the island, and two contained addled eggs and young birds. The parents had been feeding the latter on limpets and beetles. Mr. Arthur Brooke, who accompanied me on several of my expeditions, has obtained in the neighbourhood of Ardara dunlins' eggs, and at Lough Eske those of the merganser. He informed me, also, of Mr. Heardman's having taken the eggs of the red-throated diver on the Dunglow Lakes. Teal also breed there frequently. To my friend, Arthur Brooke, and other gentlemen whose courtesy and hospitality were of

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[1] The following species may be mentioned as characteristic of the limestone country mentioned above:—Sesleria cærulea, Juniperus communis, Antennaria dioica, Campanula rotundifolia, Hieracium iricum, Corylus avellana, Rubus saxatilis, Hypericum perforatum, Ilex aquifolium, Solidago virga-aurea, Thymus serpyllum, Euonymus europæus, Melampyrum pratense, Prunus communis, Sanicula europæa, Agrimonia eupatorium, Juncus obtusifolius. It is worthy of notice that the prevailing belief that Rhododendrons and Azaleas will not grow on limestone does not hold good in Donegal. At Brown Hall, Lough Eske, Ardnamona, and elsewhere, the ordinary out-door species thrive to perfection on limestone.

the utmost assistance, and rendered my labours pleasurable, I am fain to acknowledge my sense of indebtedness. The many records from Cliff and Brown Hall will show that my sojourn there was of much benefit to the object in view.

Another advantage I had in the season, which was unusually propitious for out-door pursuits, was the long period of dry weather, rendering the banks of lake and river easier of exploration than they have been for many years. In the Erne (though this was partially due to the drainage works) the life of the banks and edges of the river was exposed in a most interesting way. Multitudes of river cray-fish (*Astacus fluviatilis*) were crawling about in the slime, and thoughts of bisque soup, and yet another new Irish industry presented themselves to my mind. Another result of the heat, I presume, was the multitude of wasps; and my friend, Mr. A. Wallace, of Ardnamona, noted an interesting fact in connexion with these insects. He found their nests in several instances had been visited and pilfered by badgers. There was no doubt on the subject, their tracks and hairs affording plentiful evidence. I find this observation given doubtfully in Bell. It is another argument in favour of a harmless, nay, useful animal, needlessly persecuted. It is curious to find the old belief in two sorts of badgers, the "pig" and the "dog," still alive in Donegal; and still stranger to learn that in some parts the country folks still believe in his having the legs on one side shorter than the other, to enable him to travel comfortably on a hill-side. Is it true or not, as often stated by the country people, that the badger is very destructive to eggs of all sorts?

I have the pleasure of thanking Mr. Arthur Bennett and Mr. James Backhouse for examining series of plants in their special lines; and my friend, Mr. A. G. More, has as usual gone over my specimens and given his valuable opinions thereon.

In conclusion, I may mention my Donegal total is now well over seven hundred species, and exceeds that of Mr. Allin's, of Cork, which is the only county in Ireland as yet made the subject of a special Flora. This is a very suggestive and interesting result.

LIST OF SPECIES.

Thalictrum minus, Linn., var. *flexuosum*. Broken limestone ground near Brown Hall, Donegal, where it was shown to me by Major Hamilton. On examination I found it occurred in considerable quantity and in several detached localities. An addition to the Flora of Donegal.

Thalictrum alpinum, Linn. At 1400 feet, looking north on Alt Mountain, about four miles south of Ardara.

[*Ranunculus lingua*, Linn. Mr. Allingham[1] has recorded this species from near Ballyshannon, south side of the river, below the bridge. I have searched the place carefully. It is not a likely locality, and I fear there is an error.]

[*Ranunculus auricomus*, Linn. Mr. Allingham informs me that he has found this species in woods near Ballyshannon; he thinks at Laputa.]

R. droustii. Kiltooris Lake, near Ardara. Identified by Mr. Arthur Bennett. On mud.

Aquilegia vulgaris, Linn. Limestone thickets, about half a mile south of Patterson's Lake, in the townland of Carrigahorna, between Cliff and Brown Hall, and again nearer Brown Hall; in a wild country quite removed from cultivation. An addition to the Flora of Donegal.

Papaver dubium, Linn. Fields near Belleek, on the way to Ballyshannon, very sparingly. Near Bundoran.

**Chelidonium majus*, Linn. Urney, on the Donegal side of the Finn by the roadside. Very local, and not native in Donegal.

Barbarea vulgaris, R. Br., var. *β arcuata*, Reichb. Banks of the Erne, by the ruined mill about a mile below Cliff.

Arabis hirsuta, Linn. Sand-hills, north-west of Ardara. Mr. Allingham records *A. ciliata* from "rock, north side of estuary, Ballyshannon." *A. hirsuta* is not unfrequent in the limestone district of South Donegal.

Sinapis alba, Linn. Fields above Moynalt, near Laghy, Donegal.

Viola canina, Linn. By the Termon river above Pettigo.

Draba incana, Linn. Sand-hills south side of Boylagh Bay, and on the hill of the "standing stone" in the sand-hills north-west of Ardara. This is the second Donegal locality. I had found the plant previously near Buncrana.

Reseda luteola, Linn. Wash-pool, near the flax dam, Ballyshannon.—Allingham.

Drosera intermedia, Hayne, and *D. anglica*, Huds. Cliff bogs, near Belleek.

Saponaria officinalis, Linn. By the railway between Belleek and Ballyshannon near the bridge at "Rowan Tree Hill." The only Donegal locality which I am acquainted with.

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[1] Mr. Allingham is author of a very interesting History of Ballyshannon, to which he has appended a botanical notice of that part of Donegal. His name will appear several times in this report. Following my custom, I have enclosed in brackets those species I have not seen myself.

Lychnis githago, Linn. Moynalt and Laghy.

Lychnis diurna Sibth. By Kiltoris Lake, and elsewhere on Boylagh promontory.

Sagina apetala, Linn. Walls at Killybegs.

Geranium sanguineum, Linn. Limestone bluffs, near Ballyshannon, across the Erne. This, the second locality in the county, was made known to me by Mr. Allingham.

S. dissectum, Linn. By the Termon river and elsewhere; sparingly distributed.

G. lucidum, Linn. With the last, and in several places in the limestone country from Brown Hall to Carrigahorna. *G. phæum*, L., is established near Templecarn.—Miss Young.

Radiola millegrana, Linn. Coast between Slieve-a-Toory and Magheragh.

[*Erodium moschatum*, Linn. In the rabbit warren, south side of the river, near Ballyshannon.—H. Allingham.]

Euonymus europæus, Linn. A variety with very narrow, almost linear leaves, occurs by the Erne, a little below Cliff. It does not differ in other respects from the type which is very frequent on the limestone.

[*Rhamnus catharticus*, Linn. I regret to say the locality given for this species in my last Report is outside the county boundary.]

Ulex europæus, Linn. About Moynalt and Laghy, frequent; and native in the hills east from Ballintra, &c.

[*Melilotus alba*, Willd. Introduced, and perhaps established amongst sown grasses near Greencastle, Innishowen.—W. E. Hart.]

Ononis arvensis, Linn. My cousin, W. E. Hart, of Kilderry, has sent me specimens of the plant from Innishowen. The station is along the roadside between Fahan and Buncrana. As far as I am aware, this is an addition to the Flora of the county. Like *Œnanthe phellandrium*, *Nasturtium amphibium*, and one or two others, this species has been accredited with "11" in the *Cybele Hibernica* without any given evidence on the subject.

[*Trifolium arvense*, Linn. Old pasture-land at Woodtown (?).—Allingham.]

Agrimonia eupatorium, Linn. By the Erne and Termon rivers; north coast of Boylagh promontory, near Lough Keel Island.

Prunus padus, Linn. Termon river, above Pettigo; river between Ardara and Glenties.

Rubus saxatilis, Linn. Abundant and characteristic on the limestone country south of Brown Hall.

Rosa arvensis, Linn. Roadside, near Termon; M'Grath's Castle, below Pettigo; and by the Termon river above Pettigo.

Pyrus aria, Sm. Near Brown Hall, in several places. A hybrid between this species and *P. aucuparia* was observed near Brown Hall, and on the Finn, near Cloghaun. I believe it is a cultivated form.

Myriophyllum spicatum, Linn. Swampy place near the sea on the north shore of Boylagh promontory, north of Cloonea Lake.

Saxifraga stellaris, Linn. Mountains about Ardara and Slieve-a-Toory.

S. aizoides, Linn. Alt Mountain, near Ardara, abundant, from 1400 to 650 feet. This is the second locality in county Donegal. Mr. Arthur Brooke, of Killybegs, who helped me much in the exploration of this mountain, was the first to find this saxifrage.

S. oppositifolia, Linn. Steep banks close to sea level on the coast between Slieve-a-Toory and Magheragh, forming the sward in some places.

S. tridactylites, Linn. Limestone ledges by the Erne, below cliff on the opposite bank. This species, which is not rare on the larger sand-hill districts by the coast in Donegal, seems seldom to occur inland. In the south and midland counties it frequently appears inland on old walls, &c., but not on the coast, as far as I have observed.

[*Sempervivum tectorum*, Linn. Frequent in the district on cottages, where it is planted both for the luck it confers, and for its medicinal properties.]

Sedum rhodiola, D. C. Slieve-a-Toory; Ardara Mountains, &c.; grassy pastures at Dunmore Head, Ardara.

Helosciadium nodiflorum, Koch. Croaghlinn Lake, near Killybegs; shore at Wardtown, near Ballyshannon.

Sanicula europæa, Linn. This frequent species is very highly thought of as a cure for consumption. It is sold under the name of "Sinicle" for this purpose in the town of Donegal and elsewhere in Ulster.

Œthusa cynapium, Linn. About Ballyshannon.

Torilis nodosa, Gœrt. Appeared very sparingly as an introduced weed at Greencastle, Innishowen. A specimen was sent me by W. E. Hart.

Scandix pecten-veneris, Linn. Corn-fields near Ballyshannon.

**Sambucus ebulus*, Linn. Roadside near Donegal, on the way to Lough Eske; at Brown Hall; waste ground by a farm-house south of the Erne in the southern corner of the county.

Galium boreale, Linn. Broken limestone ground, opposite Ballyshannon, on the south side of the river in the townland of Carrickbeg.

Valeriana officinalis, L., var. *sambucifolia*. On limestone shingle by the Erne, below the bridge at Belleek.

Knautia arvensis, Coult. Fields on the east side of the Donegal road, about two miles from Ballyshannon. Very rare in Donegal.

[*Lonicera xylosteum*, Linn. Has been known to grow in the woods at Brown Hall for a century, and there is no tradition of its having ever been introduced; but I presume this must have been the case.]

Gnaphalium sylvaticum, Linn. Pettigo; between Lough Finn and Glenties.

Filago germanica, Linn. Sand-hills at Magheragh.

Anthemis nobilis, Linn. By the Erne, right bank below cliff; by the stream a little above Killybegs.

[*Matricaria parthenium*, Linn. Abundantly established on the bridge at Belleek.]

Saussurea alpina, D. C. Alt Mountain, near Ardara, at 1350 to 1400 feet.

Centaurea cyanus, Linn. About Moynalt and Brown Hall, Laghy and Ballintra.

‡*Carduus crispus*, Linn. By the Erne below the Belleek bridge, amongst waste heaps.

Hieracium argenteum, Fr. Moynalt, near Laghy, in a river glen. Determined by Mr. James Backhouse.

H. gothicum, var. By the Mournebeg river, at the boundary of the county south of Stranorlar. This is the same variety as that from Carrick river, which Mr. Backhouse considers "like *H. norvegicum*, Fr.," and with "heads far too numerous for *gothicum*."

H. gothicum, var. *latifolium*. Kiltooris Lake; river at Ardara and Glenties.

H. iricum, Fr. By the Erne, on limestone near Ballyshannon. This form is altogether inseparable from Backhouse's β *cerinthoides*, the lowland form of *anglicum*. Specimens from the same locality have received either name on different occasions. It is the only hawkweed I have met growing on bare, pure limestone rock. St. John's Point.

H. anglicum, Fr. Ardara.

H. umbellatum, Linn. River banks at Ardara and Glenties; Mournebeg river. This is the latest flowering plant to bloom in Donegal; it is not in full blow till about the middle of September.

H. pallidum, Fr. Aghla Mountain, between the summit and Glenties, at about 1600 feet, on exposed rocky bluffs. Determined by Mr. James Backhouse.

H. crocatum, Fr. By the Mournebeg river south from Stranorlar. This locality extends across the river to Tyrone in District 10. *H. crocatum* is an unmistakeable form.

Arctostaphylos uva-ursi, Spr. Abundant on Slieve-a-Tooey on the seaward side.

Vaccinium vitis-idæa, Linn. Aghla Mountain, above Lough Finn, near Glenties.

Convolvulus arvensis, Linn. Railway banks between Ballyshannon and Bundoran.

[*C. soldanella*, Linn. Mr. Allingham reports this species from the shore at Wardtown, Ballyshannon. I could not find it.]

Cuscuta epilinum, With. Sparingly on flax in a field by the lower river into Laghy, about two miles above the village. This species is reported to be a "troublesome weed in the flax" by old writers. I have looked into flax-fields almost annually for it for a number of years in northern Donegal, where flax is much grown; but until last season (1885) I never gathered it in Ireland. Perhaps of late years a purer seed is imported.

Lycopsis arvensis, Linn. Fields on sandy ground in the Boylagh promontory near Ardara, very sparingly.

Lithospermum arvense, Linn. Railway banks between Ballyshannon and Bundoran; by the shore at Wardtown, near Ballyshannon.

†*Symphytum officinale*, Linn. By the Termon river, above Pettigo.

Solanum dulcamara, Linn. This species is native in limestone thickets by the Erne, opposite cliff, and lower down; by roadsides, in old hedges on the Ballyshannon road near Donegal, and by the upper river below Laghy. [*Antirrhinum majus*, Linn. Established many years on old walls at White House, Killybegs.]

**Atropa belladonna*, Linn. The discovery of this species in a remote, rigorously wild-looking locality, was a great surprise. It grows abundantly on an exposed, low, limestone rocky place above tide-mark on the south side of Gweebarra Bay, east of Innishkeel Island. The ground above is wild, unbroken, sheep pasture, and there is no sign of cultivation in the neighbourhood. A small cabin, about half a mile away, is the nearest habitation. The geographical range of this species alone precludes us from accepting it as a native. It is very rarely found in Ireland, only in two or three localities, and those always at ruins or near houses. Mr. Arthur Brooke, who was with me at the time, helped me to search for any remains of ancient habitation or cultivation, but we saw none.

Scrophularia aquatica, Linn. Roadside from Pettigo to Lough Derg, about a mile and a-half from Pettigo. Local in Donegal.

Veronica montana, Linn. Thickets on the island immediately below Cliff House by the Erne; Brown Hall. Very local, and perhaps confined to south-west of the county in Donegal.

Lycopus europæus, Linn. Croaghlinn Lake, near Killybegs, and Brockagh Lake. Very rare in Donegal.

‡*Origanum vulgare*, Linn. By a ruined mill on the right bank of the Erne about a mile below Cliff; on an old wall at Brown Hall. An addition to the Flora of the county.

Calamintha officinalis, Mœnch. Plentiful at a limestone quarry close to Abbey Assaroe, near Ballyshannon. This addition to the Flora of the county is due to Mr. Allingham. The record opposite "11" under this species in the *Cybele Hibernica* belongs to *C. clinopodium*.

‡*Verbena officinalis*, Linn. I have already reported this species on Miss Young's authority. Last year I visited the place and found a compact little colony of this species by the road-side close to Termon M'Grath's Castle. It is very rare—one other locality (?)—in Ulster.

Chenopodium bonus henricus, Linn. Killybegs.

Polygonum raii, Bab. Coast of Boylagh promontory, north-west of Ardara, in several places.

[*Fagopyrum esculentum*, Linn. In a field with vetches, Moynalt, near Laghy.]

Callitriche autumnalis, Linn. Cloonea Lake, near the coast, north-west from Ardara.

Euphorbia exigua, Linn. By a ditch near Greencastle, sparingly, and probably accidentally introduced.—W. E. Hart.

**Humulus lupulus*, Linn. Near Carrick, below the bridge over the Aughra river; quite at home in a native-looking situation.

Ulmus montana, With. Apparently native about Brown Hall, and in the limestone glens of Moynalt, near Laghy.

†*Salix fragilis*, Linn. By the Termon river above Pettigo; by a small stream above Carrowkeel in Fanet.

S. pentandra, Linn. Near Pettigo, by the Termon, I saw a tree 30 feet high, with a stem 15 inches in diameter.

S. herbacea, Linn. Slieve-a-Tooey; Alt Mountain, near Ardara; Aghla Mountain, at Finnstown.

Orchis pyramidalis, Linn. Sand-hills north-west of Ardara, and between Magheragh and Slieve-a-Tooey; sand-hills at Greencastle, Innishowen—W. E. Hart; meadows by the river a little below Cliff.

Habenaria albida, R. Br. Cliff, near the river below the house; on slopes of hill crossing from Templecarn to Ballyshannon-road.—Miss Young.

Listera cordata, R. Br. Slieve-a-Tooey.

Epipactis palustris, Linn. Wet, sandy ground near a shallow lake below the "Standing Stone" in Boylagh, north-west of Ardara.

Neottia nidus avis, Bach. Brown Hall, where my attention was called to it by Major Hamilton. The second locality in the county.

**Iris fœtidissima*, Linn. Abundantly established near the house at Brown Hall.

Eriocaulon septangulare, With. Kiltooris Lough, near Ardara, in the barony of Boylagh. This locality extends line marking range in *Cybele Hibernica* map to the southward.

Juncus obtusiflorus, Ehr. By a small pond in limestone rocky ground near Ballyshannon, on the south side of the river Erne; lakes on limestone between Brown Hall and Cliff.

Luzula pilosa, Willd. Woods at Cliff.

Sparganum simplex, Huds. Cloonea Lake, by the coast north-west of Ardara. The "floating state, often named *S. affinis*" (W. H. Beeby), occurred in the river between Ardara and Glenties. These have been submitted to Mr. Arthur Bennett.

S. natans, Linn, var. *alpinum*. Lakes on Aghla, above Finntown, at 1800 feet. Named by Mr. W. H. Beeby. A common mountain form in north and west.

S. minimum, Fries. Kiltooris Lake, near Ardara, and Brockagh Lake, Killybegs.

Potamogeton heterophyllus, Schreb. Kiltooris Lake, near Ardara.—A. Bennett.

P. prælongus, Wulf. At the southern end of Lough Finn on the south margin of the lake, plentiful. This species has been determined by Mr. Arthur Bennett. It is a very rare plant in Ireland, but has been found in Mayo and in the north-east, so was to be expected in Donegal.

P. nitens, Web., var. *P. intermedius*, Tis. (?). In a still part of the Erne river, a little below Cliff, by the right bank. Mr. Bennett writes:—"A form closely approaching Swedish species, named by Dr. Tiselius *P. intermedius*, Tis. (ad *nitens*). There being no fruit, I cannot confidently say whether *heterophyllus* (*forma*) (?), or *nitens* (*forma*) (?)." *P. nitens*, Web., to which we may, I think, safely refer the Erne plant, is an addition to the Flora of Donegal.

P. gramineus, Linn. (*P. obtusifolius*, Mert. and Koch.) In a deep dyke at the narrow end of St. Catherine's Lake, south of Killybegs. It is abundant here, but could hardly be reached except during a dry season. This species is recorded in the *Cybele Hibernica*—"Lakes in Fanet, Donegal." There is no lake in Fanet I have not frequently examined, and I have never been able to find this conspicuous species till now. It must be very local, indeed, in Ireland. Determined by Mr A. Bennett.

P. crispus, Linn. Kiltooris Lake, near Ardara.—A. B.,—a young state, not easily recognizable; in the Erne river.

Cladium mariscus, R. Brown. In lakes, near Cliff, Belleek; Sheskinmore, and other lakes, amongst the sand-hills north-west of Ardara.

Scirpus pauciflorus, Lightf. Damp places in sand-hills north-west of Ardara; by a small pond on the limestone opposite Ballyshannon, south side of river; left bank of Erne, a little above Ballyshannon.

S. tabernæmontani, Gm. Kiltooris Lake, near Ardara.

S. sylvaticus, Linn. Termon river, above Pettigo, sparingly, near the town; abundant near the source of the stream at the edge of the county. The only locality in Donegal except that of the Finn, given in the *Cybele*, which I, however, failed to verify.

Blysmus rufus, Panz. Kiltooris Lake, Boylagh promontory, near Ardara.

Eriophorum latifolium, Hoppe. Plentiful in low, rushy, coarse pasture near the sea by Lough Sheskinmore, north-west of Ardara. A very rare species in Ireland, and additional to Donegal Flora. Mr. More and Mr. Bennett agree in this decision, but the specimens were rather far advanced. I have gathered the plant by the Suir, in Tipperary, and recognized it at once.

Carex curta, Good. Brockagh Lake, near Killybegs. Occurring in one isolated patch. Mr. A. G. More has recorded this rare sedge "in a wet bog near Killybegs." Possibly the same locality. I have not met it elsewhere.

C. rigida, Good. Alt Mountain, near Ardara; Slieve-a-Tooey; Aghla, above Lough Finn.

C. stricta, Good. Plentiful by the Erne river. This has been named by Mr. A. Bennett.

C. pallescens, Linn. By the Termon river, above Pettigo.

C. vulgaris, var. *goodenovii*, Gay. Slieve League. An alpine form.

C. strigosa, Huds. Amongst thickets on the island immediately below Cliff, in the Erne river.

C. filiformis, Linn. Stream leading out of Sheskinmore Lake, north-west of Ardara; lake near Cliff.

C. vesicaria, Linn. Brown Hall; Termon river, Pettigo.

Phleum arenarium, Linn. Sand-hills, north-west of Ardara.

Sesleria cærulea, Scop. By the Termon river, above Pettigo.

Catabrosa aquatica, Beauv. Wet places in sand-hills north-east of Ardara.

Triticum caninum, Linn. By the Termon river, above Pettigo.

‡*Lolium temulentum*, Linn. Cliff, near Belleek.

Cryptogramme crispa, R. Br. Very sparingly on Alt Mountain, near Ardara. The parsley fern has not been previously found in Donegal. Mr. Arthur Brooke, of Killybegs, was with me when I discovered it, and he alone (besides myself) knows the exact locality.

Polypodium phegopteris, Linn. Alt Mountain, near Ardara; above Lough Finn; woods by the coast between Slieve-a-Tooey and Magheragh.

Lastræa thelypteris, Presl. Limestone shingly places, near the River Erne, on the right bank immediately below Belleek. This is a distinct locality from my friend A. G. More's for the same species, which is near Ballyshannon, along the same river. A very local fern.

Polystichum aculeatum, Roth., and *P. angulare*, Newm. By the Erne, opposite Cliff.

Cystopteris fragilis, Bernh. On a bridge over the Termon river, above Pettigo; Alt Mountain, near Ardara; rivers above Laghy, at Moynalt, &c.

[*Asplenium viride*, Huds. Banagher mountain, above Lough Eske. Miss Sinclair informs me that her brother found this fern there.]

Ceterach officinarum, Willd. Walls of outhouses, &c., at Brown Hall; abundant. Very rare in Donegal, occurring in but one other locality. Mr. Allingham records it elsewhere near Belleek, but on searching the locality I fear it has disappeared.

Botrychium lunaria, Linn. Templecarn, near Pettigo—Miss Young. At Gweedore—P. Mahony.

Ophioglossum vulgatum, Linn. Brown Hall; Stone Park, near Ballyshannon.

Lycopodium alpinum, Linn. Alt Mountain, near Ardara; Aghla Mountain, above Lough Finn.

The following *Characeæ* have been determined by Mr. Arthur Bennett:—

Chara fragilis, Desv. Kiltooris Lake, near Ardara.

C. contraria, Fr. Kiltooris Lake, with the last.

Nitella opaca, A. In a small lake on the left bank of the Erne, close to it, above Ballyshannon.

In the foregoing list the following are additions to the Flora of the county Donegal. With these are included a few which I have had some doubts about, or which have been erroneously recorded. Any of which I still have doubts are omitted. Varieties are bracketed:—

Thalictrum minus, Linn., var. *flexuosum*.

[*Ranunculus drouetii*, F. Schultz. A form of *tricophyllus*, perhaps hardly worth distinguishing.]

Aquilegia vulgaris, Linn.

[*Barbarea arcuata*, Reich. A variety of *B. vulgaris*.]

Saponaria officinalis, Linn. Recorded, but without locality, in the *Cybele Hibernica*.

Ononis arvensis, Linn. Recorded, but without locality, in the *Cybele Hibernica*. Like the last, it appears to be at any rate very rare in Donegal.

**Torilis nodosa*, Gœrt. [*Lonicera xylosteum*, Linn.; *Matricaria parthenium*, Linn.]

**Cuscuta epilinum*, Weihe.

**Atropa belladonna*, Linn.

†*Origanum vulgare*, Linn.

Calamintha officinalis, Mœnch.

Potamogeton prælongus, Wulf.

P. nitens, Web.

P. gramineus, Linn.

Scirpus sylvaticus, Linn.

Eriophorum latifolium, Hoppe.

Cryptogramme crispa, R. Br.

Chara contraria, Fr.

Nitella opaca, Ag.

XXXIII.—ON THE FLUID STATE OF BODIES COMPOSING OUR PLANETARY SYSTEM. By HENRY HENNESSY, F.R.S., Professor of Applied Mathematics in the Royal College of Science, Dublin.

[Read, February 22, 1886.]

DURING the past two centuries the constitution of the earth and other bodies composing our planetary system has been a frequent subject of physical and mathematical inquiry. The outswelling of the earth at the equator and its flattening at the poles were accounted for by Newton and Clairaut on the hypothesis of its original fluidity; and the shapes of some of the greater planets were similarly explained. Laplace proposed a theory of the formation of the whole planetary system, including the satellites, in which the condition of fluidity formed an essential part. But the former fluidity of the earth, as well as the nebular theory of Laplace, seems not to have been universally admitted. Playfair, in the illustration of the Huttonian theory, attempted to prove that a solid nearly-spherical body, coated with water, would acquire, by abrasion, the observed spheroidal figure of the earth. Sir John Herschel afterwards followed in the same path; and an eminent geologist of recent times, Sir Charles Lyell, employed the arguments of these mathematicians in support of his theories. A member of this Academy, the Rev. Dr. Samuel Haughton, has published, in our *Transactions* for 1852, a Paper, in which he proposed to examine, among others, this question—"Whether the evidence of the original fluidity of the earth and planets, afforded by their observed figures, is satisfactory with respect to all the planets; whether we possess, from the data afforded by astronomy, sufficient knowledge of the structure of the interior of the earth to enable us to draw conclusions respecting it which are of geological value." His answer to these questions was in the negative; and as it now seems that they should, on the contrary, be answered in the affirmative, it appears desirable that the Academy should be placed in possession of the evidence for coming to a correct judgment on the question.

Most of my recent researches on the figures of the planets have been communicated to the French Academy of Sciences; and they have appeared in its *Comptes rendus*. In 1874, a French mathematician, M. Amigues, reproduced a result I had long before discovered; and after establishing my priority to the discovery in the *Comptes rendus* for October, 1878, I applied this result to the inquiry as to whether the theory of superficial abrasion or that of entire fluidity of the planets would be best adapted for explaining the results of observations made in recent times on the figures of the planets.

I had long since proved, in a Paper printed in the *Proceedings* of this Academy, vol. iv., that Playfair's method of accounting for the

earth's spheroidal figure could not be considered as satisfactory as the fluid theory; and more recently I have shown, in the *Comptes rendus* of the Paris Academy of Sciences,[1] that the observed figure of the planet Mars can be accounted for on the latter theory of its original condition, while the theory of superficial abrasion completely fails. So far as it is possible to know the figures of the other planets, it also appears that these figures conform to the theory of fluidity much better than to the theory of superficial abrasion. The objections of Dr. Haughton to the general fluidity of the planets fall to the ground as completely as those of Playfair to the original fluidity of the earth. But while the theory of superficial abrasion fails to account for the figures of the earth and planets, some inquirers have recently maintained that such bodies, if totally solid, would acquire a spheroidal shape under the action of rotation.[2]

Figure of a Rotating Fluid compared to a Rotating Solid.

If a mass of fluid, whose density increases from its surface to its centre, rotates with an angular velocity so small as to cause its surface to differ but little from a spherical surface, it has been proved that the fluid would consist of strata of equal density with spheroidal surfaces similar to that of its outer stratum. The outer stratum will be bounded by an ellipsoid of revolution. A cross section of the whole spheroid in the plane of the axis of rotation would thus show the strata of equal density arranged about the centre with elliptic cross sections. It has been, moreover, proved that the ellipticity of these strata decreases from the surface to the centre.[3] This result is independent of any hypothesis as to the law of density of the strata; and its application to the earth is generally admitted. If the earth had arrived at its present state by the solidification of its crust, without any change whatsoever in the position of the particles of matter from which the crust solidified, the strata of the crust, from its outer to its inner surface, would preserve the shapes they had when in a fluid state. If, as I have demonstrated, the ellipticities of the strata of the shell become greater than the ellipticity of its outer surface, the cross section through the earth's shell and nucleus would be illustrated by fig. 1. This result is independent of any hypothesis as to the law of density of the matter composing the earth, and rests on the admitted assumptions as to the mechanical and physical properties of the materials of the earth by which its figure has been investigated. Far from having any hypothesis in order to find this result, it was obtained by rejecting the

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[1] *Comptes rendus de l'Académie des Sciences*, Paris, June 14, 1880. *Phil. Mag.*, August, 1880. *Ib.*, Jan. 31, 1881, p. 226. *Ib.*, April, 1881.

[2] See W. B. Taylor, *American Journal of Science*, October, 1885.

[3] See Airy's *Mathematical Tracts*, Pratt on *Attractions*, p. 177; Pontecoulaut, *Theorie Analytique du Systéme du Monde*, vol. ii.; Resal, *Traite Elementaire de Mecanique Celeste*, p. 221.

erroneous mechanical and physical assumption which asserts that the particles of the solid shell retained the same places which they held when they were liquid. When a solid, continuous shell had been once formed, it is manifest that it would constitute for the liquid nucleus, and the semi-liquid matter passing into the solid state, a casing far less yielding than the substances enclosed within it. These

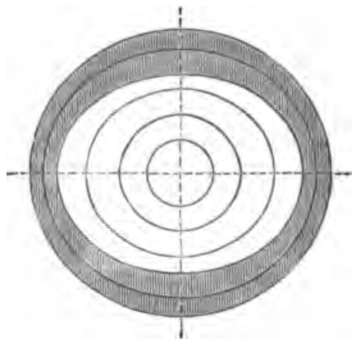

Fig. 1.

plastic substances would, as I have already pointed out, tend to freely arrange themselves according to the hydro-dynamical laws; and thus the arrangement of the strata of the shell and nucleus above indicated must necessarily follow. Each successive stratum added to the shell's inner surface by solidification from the nucleus would be moulded against the existing shell into a shape corresponding to that of the surface of the fluid mass.

The plastic character of solids shown by the effect of the die on medals, the forcing of solids under pressure to change shape, has led to the inference that the earth and planets may have acquired their oblate figures without ever having been fluid.

This fallacy arises from observing solids on the earth's surface acted on by gravity. A solid sphere of lead, ten feet in diameter, placed on a flat place, would probably be slightly flattened, and its poles become less than its equivalent diameter. But if so, the result would be due to the action of parallel forces. The diagram (fig. 2) represents the sphere acted on by this force, and (fig. 3) the same sphere acted on only by the force of attraction directed to its centre, C. The resulting effects in both cases would be totally different.

The force resulting from an angular velocity such as in the earth would be only $\frac{1}{289}$th of the parallel forces in the first case. The force resulting from this cause would be so small as to have no sensible effect except on extremely yielding masses, such as liquids. All experiments on solids at the earth's surface are illusory on account of the parallel action of gravity when applied to such matter. A round

dumpling or pudding of soft matter flattens if placed on a table; but this would not occur if all the forces were directed to its centre. The globe of lead already mentioned, if melted by heat, would be flattened

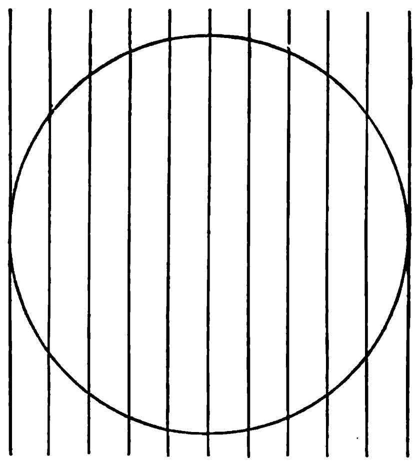

Fig. 2.

out completely under the action of parallel forces, as would all liquids; or the oblateness of a perfect liquid would, in that case, be infinite.

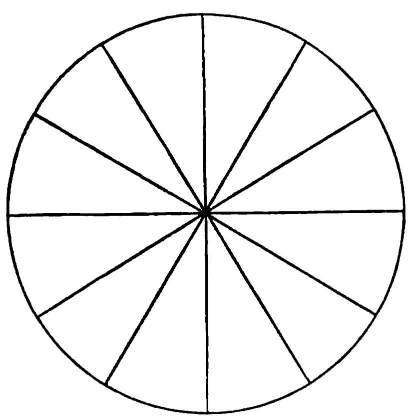

Fig. 3.

No sharp mountain peaks of great altitude could exist; they would be flattened into semi-rounded masses. But all observers concur in

thinking that the changes in steep and lofty rock-masses, such as the Aiguilles of Mont Blanc or the Matterhorn, are entirely due to weathering, and not to the squeezing down of the masses by gravity. The effective action of gravity upon a cone or pyramid, in squeezing it down, can be easily shown to be likely to produce a change of shape only if the matter was soft, but none if hard. A mass of rocks, with vertical sides, is acted on by changes of temperature and moisture, rain, frost, snow, and air, so as to gradually degrade it; but conceive all of these agencies absent, the sole force acting on its gravity—and although this is 289 times at least as great as the centrifugal at the equator—it could not be concluded, nor has it ever been proved that gravity has caused such a mass to be in the slightest degree flattened. If rocks were so plastic that $\frac{1}{289}g$ could mould them, all the earlier mountains would have been long since flattened down. A force more than two hundred and eighty times as great as the greatest amount of centrifugal force has acted for more than fifty centuries on the pyramids of Egypt and other structures raised by man, and yet not the smallest compression can be proved. It is therefore inconceivable that the very small force resulting from the angular velocity of the earth could produce any such effect. If a fly-wheel or a mill-stone continues to rotate with a small angular velocity, no change in its form can be observed. But if it received such a rapid rotation as to create a centrifugal force very much greater than gravity, instead of changing its shape it breaks to pieces. No instance has ever been recorded of a fly-wheel or a mill-stone, rotating at their usual angular velocities, having received the slightest change in its form. Yet the angular velocity of a mill-stone or fly-wheel is usually many thousand times as great as the angular velocity of the earth.

For every mountain slope, whose inclination exceeds the angle made by the normal at any point of a sphere to the direction of centrifugal from any gravity, has a force acting on it far exceeding centrifugal force at the equator. If a be radius of a base of a conical mountain, and h its height, then gravity acts on its slope with a force $= g\frac{h}{\sqrt{a^2+h^2}}$, in order that this force $= f$.

$$\frac{a^2+h^2}{h^2} = (289^2), \text{ or } 289^2 - 1 = \frac{a^2}{h^2}, \frac{h}{a} = \frac{1}{\sqrt{289^2-1}},$$

$$\text{or } \frac{h}{a}\left(1+\left(\frac{h}{a}\right)^2\right)^{-\frac{1}{2}} = f = \frac{h}{a}\left(1-\tfrac{1}{2}\frac{h}{a}, \text{\&c.}\right),$$

or the ratio of height to its base would be $\frac{1}{478}$ nearly.

A mountain with a base 478 miles and a height of 1 mile is acted on by a force equal to that of centrifugal force.

A mountain 5 miles high, with a base of 100 miles, is acted on by

a force nearly 30 times as great, and yet such mountains are not in the slightest degree flattened down.

No proof has been ever adduced that any of the great table-lands of the continents have been flattened down in this way. Such masses in Central Asia, could not maintain their height if the solid materials of the earth possessed the plasticity invoked by such speculation as to the earth's figure.

If rotation would cause a solid sphere to acquire such a figure as that of the earth, then, if the rotation were to cease, the spheroid would change its shape back again, and become spherical. Regarding the earth as a sphere, with an equatorial protuberant zone, then, if it ceased rotating, this zone would be subjected to gravity, acting upon it just as gravity acts on the slope of a mountain, or a gradually elevated table-land. As the protuberance is about thirteen miles, and the distance, counted in a meridian to the pole, is nearly six thousand miles, the average slope would be less than in 470. We know that mountains of five miles, and great chains averaging over three miles, remain perfectly free from the smallest squeezing down, as far as we can see, unless what is due to weathering. If chains or elevations whose average slope is at least fifty times as great, and to which the degrading action of gravity is therefore nearly fifty times as great, undergo no collapse, we may be assured that this could not occur in the case of the earth's oblate protuberance if our planet ceased to rotate.

While the hypothesis of the former fluidity of the planets fully explains their figures, we see that every attempt on the supposition of solidity completely breaks down. Attempts at proving the present solidity of the interior of our earth have been shown to be invalid[4]; and that member of the planetary system which rules it—namely, the sun—has been long since observed to be chiefly in a fluid condition. The close connexion between the physical conditions of the various members of our system seems to be thus completely verified; and their former fluid condition may be fairly accepted as an established truth.

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[4] *Comptes rendus* for 1868, and 6 Mars, 1871; also *Nature*, v., p. 288, and xv., p. 78.

XXXIV.—On the Orbit of the Binary Star O. Struve 234. By J. E. Gore, F.R.A.S.

Read, February 8, 1886.

The elements of the orbit of this binary star have not, as far as I know, yet been published. The components are of magnitudes 7 and 7·4, and it has always been a close and difficult object to measure even with large telescopes. Some of the recorded observations are very discordant, which renders the calculation of a satisfactory orbit difficult and uncertain.

By the method described in my Paper[1] on β Delphini I have computed the following elements, which must of course be considered only as a first approximation :—

Elements of O. Σ 234.

$P = 63{\cdot}45$ years.

$T = 1881{\cdot}15$.

$e = 0{\cdot}3629$.

$\gamma = 47^\circ\ 21'$.

$\Omega = 124^\circ\ 11'$ (1880·0).

$\lambda = 71^\circ\ 58'$.

$a = 0''{\cdot}339$.

$\mu = +\ 5^\circ{\cdot}67$.

The position of the star for 1880·0 is—

R. A. $11^h\ 24^m\ 20^s$.

Decl. $+\ 41^\circ\ 58'$.

The following Table shows the comparison between the recorded measures and the positions computed from the above elements :—

[1] *Ante*, p. 538.

EPOCH.	OBSERVER.	θ_0	θ_c	$\theta_0 - \theta_c$	ρ_0	ρ_c	$\rho_0 - \rho_c$
1843·29	O. Struve.	*182·0	167·4	+ 14°·6	0″·49	0·36	+ 0″·13
1844·31	,,	172·9	170·7	+ 2 ·2	0 ·53	0·35	+ 0 ·18
1846·37	,,	177·3	177·5	− 0 ·2	0 ·37	0·34	+ 0 ·03
1847·41	,,	183·3	179·5	+ 3 ·8	0 ·44	0·34	+ 0 ·10
1848·25	,,	187·7	184·2	+ 3 ·5	0 ·37	0·33	+ 0 ·04
1850·31	,,	195·1	192·1	+ 3 ·0	0 ·32	0·32	0 ·00
1851·42	,,	198·2	196·3	+ 1 ·9	0 ·27	0·32	− 0 ·05
1851·43	,,	202·1	196·3	+ 5 ·8	0 ·32	0·32	0 ·00
1852·46	,,	*196·0	200·6	− 4 ·6	0 ·27	0·31	− 0 ·04
1853·41	,,	201·8	204·5	− 2 ·7	0 ·32	0·31	+ 0 ·01
1858·36	,,	*252·0	226·7	+ 25 ·3	oblong.	0·29	—
1859·40	,,	229·0	231·5	− 2 ·5	0 ·25	0·29	− 0 ·04
1861·26	,,	*257·8	240·1	+ 17 ·7	0 ·26	0·29	− 0 ·03
1861·40	,,	251·0	240·7	+ 10 ·3	oblong.	0·29	—
1862·39	,,	259·0	245·7	+ 13 ·3	,,	0·29	—
1866·49	,,	*281·0?	254·1	+ 26 ·9	perhaps oblong.	0·30	—
1870·46	,,	279·3	282·2	− 2 ·9	,,	0·29	—
1877·257	Dembowski.	318·7	321·2	− 2 ·5	0 ·25	0·22	+ 0 ·03
1877·263	,,	*295·9?	—	—	0 ·25?	—	—
1878·323	Burnham.	331·7	330·7	+ 1 ·0	0 ·27	0·20	+ 0 ·07
1880·373	,,	358·4	356·0	+ 2 ·4	0 ·18	0·16	+ 0 ·02

Some of the discordances in the angles are very large, but on examination it will be seen that those marked with an asterisk are hopelessly discordant, and it would evidently be quite impossible to find any orbit which would satisfy these contradictory measures, and at the same time represent the other angles which are fairly accordant. In the earlier and later measures, the discordances cannot be considered very great, if the difficult character of the star is taken into consideration.

XXXV.—Report of Researches at Killarney and South of Ireland: Macrolepidoptera, Etc. By W. F. de V. Kane, F.E.S.

[Read, April 12, 1886.]

There is no district in Ireland which has, for many reasons, attracted the attention of naturalists so much as that of Killarney, unless it be that portion of the eastern slopes of the Wicklow Mountains, extending from Rathnew to Powerscourt; and when it is remembered that it was the favourite hunting-ground of the experienced and indefatigable lepidopterologist, Mr. Birchall, and was also explored from time to time by Mr. Tardy, Peter Bouchard, Dr. Battersby, Mr. Wollaston, and others, a fresh and necessarily partial re-examination of this particular group of its fauna might seem superfluous. But the work done previously in this and other branches of zoology has been robbed of much of its scientific value by the want of authentic record, and the destruction and dispersal of Irish collections. That of Mr. Tardy was never labelled, so that after his death no reliable data as to locali ties could be gained from its examination, and that of Mr. Birchall has been dispersed. The only reliable data that now survive consist of such entries in Birchall's *Catalogue of Irish Lepidoptera* as record his own captures, or those of the Rev. J. Greene, and the list of microlepidoptera compiled by Mr. Barrett.

As three very remarkable species of macrolepidoptera are cited on other testimony as having occurred at Killarney, it seemed very advisable that an attempt should be made to substantiate or disprove the record. I shall, therefore, in the first place, refer to the evidence on which the occurrence of Ophiodes (Pseudophia) lunaris, Notodonta bicoloria, and Notodonta chaonia rests, and then pass on to review the general results of my three visits to Killarney, &c., and append a list of the most interesting species captured.

Ophiodes (Pseudophia, Gn.) lunaris, Schiff., is distributed on the European continent as follows:—Northern range: Leyden, Hamburg, and Mecklenburg-Strelitz, i. e. about 53½°. Over Southern Europe it is widely spread from Spain to the Volga (Speyer). It has twice been met with in England—once in Hampshire and once in Surrey. The entry in Birchall's *Catalogue of the Lepidoptera of Ireland* stands thus: "Two specimens captured at Killarney by the late Peter Bouchard in 1864."

Being already familiar with the insect abroad, and having acquainted myself with the chief localities at Killarney worked by Bouchard, I had some hopes of following up his discovery successfully; but the atmospheric conditions prevailing last June, when this and N. bicoloria are in flight, rendered my efforts futile in respect to all nocturnal Heterocera. It only remained to gather any evidence that might

be available on the spot from those who had associated with Bouchard. With regard to the first-mentioned insect, I regret to say that I could gain no satisfactory intelligence. Its colour and appearance are in no wise remarkable to the ordinary observer, and its name seems not to have been remembered by the family with whom he lodged. Nevertheless, I have no reason to impugn the accuracy of the entry, though it would be very desirable to substantiate it, as Peter Bouchard was little known except to entomologists residing in and about London, where he had occupation at the British Museum, and was considered, I understand, a reliable man.

The larva of O. lunaris feeds on oak, and is said to be easy to rear; so that if the climate be suitable, the insect has every chance of survival among the wide-stretching oak forests of the Killarney district, which lies well south of the limit of latitude, and enjoys a milder climate than continental districts on a similar parallel. The case is different, however, I regret to say, with the rare moth which I shall now refer to, i. e. Notodonta bicoloria. This is never, I believe, found plentifully in any of its continental habitats, and the chances of its being again taken in Killarney have been much lessened of late, since the forests and moors have been everywhere denuded of birch-trees to supply a spool manufactory in Killarney, and only a small proportion spared along the main roads, so as not entirely to divest the landscape of their graceful foliage and silvery trunks.

Of the capture of five or six specimens of N. bicoloria, many years since, at Burnt Wood, in Staffordshire, a very circumstantial narrative has lately been published from the pen of one of the two naturalists who were fortunate enough to meet with it. But the authenticity of Bouchard's catch has been frequently canvassed by English entomologists, although announced at the time in the *Entomologists' Annual* for 1859 as having been made the previous summer. I ascertained the following particulars which, I think, place the matter beyond doubt. Bouchard was staying at Tower Lodge on the Upper Lake, with a deer-keeper of Mr. Herbert's, in the month of June; and from him, now an old man, I had an unmistakable description of this very remarkably coloured moth, which he said Bouchard brought home one evening, having taken it on the stem of a birch-tree somewhere in the direction of Mucross—possibly in the demesne itself. This, being new to him, he sent to London for identification, and on receipt of the answer assiduously searched the birch-trees between Tower Lodge and Dinas during the remainder of his sojourn. Next year, returning at the same season, he found the mutilated remains of a second, in a spider's web. The name of "Bicoloria" is well known to the inmates of Tower Lodge, and indeed to many residents in the vicinity.

A report, moreover, is current, that on a post in the "West-meadows" of Mucross Demesne another specimen was found a few years since by a labourer, who sold it for 10*s*. to a naturalist then staying at a hotel in Killarney. Of this I was told a notice appeared in some Natural History Journal, which I have not been able to trace.

There is nothing in the habits or climatic distribution of this insect to render its occurrence in Ireland a matter of surprise. It is included in Sven Lampa's List of Scandinavian Macrolepidoptera as being a native of Finland and Sweden, and it is taken in Livonia, N. Germany, Belgium, N. France, Central Russia, and the Ural Mountains.

The third lepidopteron of considerable interest noted from Killarney in Mr. Birchall's list, but not of his capture, is Notodonta chaonia. He writes: "I have a specimen taken at Killarney. It has also occurred in Co. Wicklow." There is some reason to believe that the specimen in Mr. Birchall's collection from Killarney was taken by Bouchard. It is a rare moth, but has been found in several localities in England, and not infrequently in Richmond Park. It, and its congeners, Dodonea and Trepida, are oak feeders, and on the Continent occurs throughout Central Europe, and in Jutland, Sweden, and Denmark. It emerges in Spring; and I was favoured by about a week of very fine warm weather on my arrival in Kilarney on the 13th of April last. On the 17th I took a fine female specimen on an oak at Derrycunnihy; and two days later I found a male, which, however, had been killed and considerably damaged. The white band on the forewings of both is very conspicuous, and the insects larger and more beautifully marked than in any English examples I have seen—a character which the Irish Heterocera very frequently possess.

I was also very successful in the sunny April weather in taking various Geometræ in the daytime. Eupitheciæ, especially pumilata and abbreviata, were numerous; also Tephrosia biundularia (= Crepuscularia) was pretty common on the tree-trunks. Tephrosia consonaria was much rarer; but the specimens were large and often finely marked. Lobophora viretata occurred not unfrequently on pine stems near Dinas. On those of birch I took more than one specimen of Zylina ornithopus (hibernated) at rest in the daytime, which illustrates the instinct frequently shown by insects in choosing a resting-place similar in colour to the pattern of their wings, with the result of eluding observation. So difficult of detection is this insect in such a situation—and, indeed, the same may be said of other species—that I was more than once surprised at my eye intuitively recognizing it; while, if I withdrew my gaze for a moment, it was very difficult to rediscover.

Boarmia cinctaria, also at Killarney, appears under the beautiful white-banded form; and for the same reason, I think, frequents the white birch bark. I took but one resting upon oak; and this was of the grey brindled pattern, which assimilated closely to the character and colour of the oak-trunk. On two occasions, also, I noticed specimens of Tephrosia biundularia, when flying from capture, suddenly settled down upon dead oak-leaves, choosing such as were coloured similarly to their wings. Tæniocampa gothica was, as usual, very abundant; and I was much surprised at taking specimens of the rare variety Gothicina, which is a Scandinavian form, but has occurred a

few times in the North of England. According to Staudinger it is a boreomorphic form, being an aberration in Lapland and a permanent variety in Finland. Several localities in Sweden, Norway, and Finland are given in the *Catalogue of Scandinavian Macrolepidoptera* by Sven Lampa. The weather became very wet from about the 20th to the 25th of April, so that little could be done after the first week of my stay.

The 8th of June found me again at Killarney in quest of Ophiodes lunaris and Notodonta bicoloria. The weather was all that could be desired in the daytime; but, at sundown, the N. E. wind, which constantly prevailed, had a most prejudicial effect, the thermometer falling suddenly several degrees; so that during the whole of June and part of July no Noctuæ would fly. In vain the various methods of attraction were tried: on a few nights only, in the warmer and sheltered portions of the forest, a few moths came to sugar; and a powerful fen-lamp attracted a few Arctia menthrasti and one or two common species. During my stay, therefore, in June, my collection was almost wholly made up of such species as were to be taken in the daytime, and I had thus to forego the greater portion of my available resources for capture.

This phenomenon was widespread. A collector at Markree, Co. Sligo, was for weeks entirely unsuccessful in taking a single specimen of various species which abound in that locality; and similar experiences were recorded from various parts of England.

The absence from my list of captures of many Macrolepidoptera, which are common in the district at that time of year, is not therefore to be taken as evidencing either want of assiduity on my part, or even temporary dearth of those species; because numerous imagos emerged from pupæ in my possession; and there was no reason to think that Noctuæ, though retarded a fortnight, were not in their usual numbers.

In Mr. Herbert's demesne several varieties were found. Charles Donovan, Esq., F.E.S., who joined me for a week, was fortunate enough to beat a specimen of Eurymene dolobraria out of an oak; and very kindly handed it me for the National Museum. There is but one previous undoubted instance of its capture in Ireland, namely, a specimen taken by Dr. Cosgrave at Swords several years ago. Three specimens of Tephrosia punctularia also fell to my net. This is a very local species; and Mr. Birchall gives Co. Wicklow and Killarney as its habitats. I have to record the capture of Lobophora sexalisata, and Eupithecia fraxinata, which are new to the Irish list. Panagra petraria is a very local insect, but occurs in some abundance in the forest near Torc Waterfall, and near Tower Lodge. Mr. Bristow has taken it in the Co. Wicklow. One specimen each of Acidalia inornata, Ligdia adustata, and Perostoma palpina (Mucross)—the two latter noted as occurring in Co. Wicklow by Birchall—were interesting additions. One Cymatophora fluctuosa was taken at dusk on the

wing—a rare species, not known to occur elsewhere in Ireland. Corycia temerata, Acidalia immutata and remutata, were pretty abundant about the Upper Lake. Among the Rhopalocera I noticed Thecla rubi very abundant everywhere, and Vanessa io. Lycæna argiolus also was very plentiful towards the end of April; but I was unable to learn whether it is monogoneutic or digoneutic at Killarney. Holly forms the chief feature of the underwood; and all along the Mucross Demesne there is no want of ivy to feed the second brood.

Pieris napi, which I took in some numbers, did not present any topomorphic or horeomorphic peculiarity; but I noticed Coenonympha typhon to be characterized by a paler colour on an average, and with ocelli more diminished in number and size than such as I have taken in the bogs of the centre of Ireland—Sligo, and Galway. Those from Killarney tally very closely with specimens I have lately received from Norway; while the examples in my possession from the central and western portions of Ireland approximate somewhat to the ab. Philoxenus of Yorkshire and Central Europe; and for this I have the authority of Professor Christ of Zurich. Mr. Birchall's note, therefore, on this butterfly, in which he says, "All the Irish and Scotch examples of this insect which I have seen are the typical form of Davus Fab.," should be restricted in its application to the South of Ireland form, and perhaps of other districts which I have never explored.

Another observation of this distinguished naturalist also is calculated to give a false impression, judging from my own experience. Referring to Erastria fasciana, Baukia argentula, and Hydrelia uncula, he says:—"Anyone who has traversed the bogs of Kerry in the early part of June will not soon forget the astonishing numbers of the three last-named insects, which rise around him as he pushes his way through the thick growth of Myrica gale." I was therefore much surprised to find that the two latter insects were extremely local in their occurrence, and it was not without hard labour and traversing considerable tracts of moor and mountain that I came upon one or two limited areas where B. argentula was plentiful and H. uncula in limited numbers, namely, at a portion of Garrymeen Bog, near Lord Brandon's Cottage, and on another patch, about half a mile distant. Single specimens were seen elsewhere, and on a spot on the slope of Mangerton, on the Killarney side, B. argentula is abundant. Erastria fasciana is more widely distributed, and seems to frequent any outcrops of rock at the edges of bogs.

I saw but few specimens of Gonepteryx rhamni, but could form no opinion of its comparative abundance in less exceptional seasons. At the copper mines in Mucross I noticed Silene maritima growing in great profusion. This abounds all along the Irish seaboard, and if its existence in Killarney be any evidence of a former intrusion here of the ocean, it might be possible that some of the coast-haunting species of Dianthœcia, which feed on the capsules of this plant, may have

also survived with their food plant here in Killarney. I spent two or three evenings watching the flowers, but in vain, the sudden fall of temperature at sunset preventing any flight of moths; and took only two Dianthœcia cucubali, an inland as well as a coast species. I should strongly suggest any future entomologist who has opportunity, to repeat the experiment in a more genial season.

At the end of October I again visited the South of Ireland, spending a week at Cappagh, near Lismore, Co. Waterford. The season was a very backward one, and the insects at least a fortnight late. During the five days I was there I noticed nothing remarkable about the entomological fauna, which did not differ to any extent from that of districts in the North and West. I have appended a list of lepidoptera which frequent this neighbourhood.

From the 3rd to the 9th of November I was at Killarney, the weather being fairly suitable, and I took several Cerastis spadicea, and a very nice series of Zylina ornithopus and Cidaria siterata which were very abundant about Mucross village. Otherwise I noticed nothing remarkable about the Autumnal species, either in number or rarity.

This concludes the record of my captures of lepidoptera in this part of Ireland. But at the request of Mr. Denison Roebuck, of Leeds, who is engaged in the examination and comparison of Mollusca from different localities of Great Britain, I collected numerous specimens of this group at Killarney and elsewhere, some of which proved to be of remarkable interest.

Two examples of Limnea involuta furnished subjects for a series of elaborate and careful drawings, and the jaws and teeth have been mounted, so that a distinct advance has been made in the knowledge of this interesting species. I shall have pleasure in laying before the Academy, as a supplement to this Report, a notice with which Mr. Roebuck has kindly furnished me, containing the results of his study of Irish Mollusca. Among them were specimens of Lehmannia arborum v. nemorosa from Killarney, establishing satisfactorily, for the first time, its occurrence in Great Britain. Another species of extreme rarity which I was fortunate enough to detect at Markree, Co. Sligo, Enniscoe near Crossmolina, Mayo, as well as at Killarney, is Limax cinereo-niger. No Irish example of this has been taken in Ireland since 1843, and only twelve altogether have been found in the United Kingdom. It is very interesting to note that this animal has its headquarters in Scandinavia, and its distribution is distinctly northern, or confined to mountainous regions.

A parallel instance among the Coleoptera of a boreal form occurring at Killarney is noticed by Wollaston; Pelophila borealis, a native of the Orkneys: which has also been taken at Lough Neagh, and near Armagh by the Rev. J. F. Johnston, and, I may add, Markree. Among the Lepidoptera, besides the two northern forms previously referred to, namely, Coenonympha typhon, and Tœniocampa gothica v. gothicina,

Mr. Birchall has noted Hadena rectilinea and the Alpine var. montivaga of Acronyctia euphorbiæ as occurring at Killarney.

We have therefore evidence of considerable significance derived from three several distinct orders of animals, which attests the survival in Ireland, and especially in Kerry, of Alpine and sub-Arctic forms. And whereas the Fauna of high latitudes, when present in more southern countries, are found to be more or less confined to lofty altitudes, we have here oromorphic and boreomorphic forms inhabiting valleys and plains only slightly elevated above the sea-level, and not only from five to seven degrees of latitude south of their Continental habitats, but in a district which enjoys a milder climate than countries on the same parallel.

And side by side with these witnesses of a former sub-Arctic climate, to which the geological features of the lakes, and the glacier-worn spurs of the surrounding mountains also testify, we find in the South of Ireland, as I pointed out in a former report, five or six distinctly S. European species of Lepidoptera to which, if we accept Bouchard's testimony, we may add Ophiodes lunaris. In connexion with the above remarks I would call attention to the preface to Wollaston's "Insecta Maderensia." The learned author points out that as regards the coleopterous fauna of Madeira "there is some slight (though decided) collective assimilation with what we observe in the South-Western extremity of England and Ireland, nearly all the species which are common to Madeira and the British Isles being found in those particular regions; whilst one point of coincidence, at any rate, and of a very remarkable nature, has been fully discussed under Mesites." He proceeds to say:—"Whether or not this partial parallelism may be employed to further Professor E. Forbes's theory of the quondam approximation by means of a continuous land, of the Kerry and Galician Hills, and of a huge miocene continent extending beyond the Azores, and including all these Atlantic clusters in its embrace, I will not venture to suggest; nevertheless, it is impossible to deny that, so far as the Madeiras betoken, everything would go to favour this grand and comprehensive idea." The Mesites referred to above is M. maderensis, which although specifically dissimilar from M. tardii of Kerry, approaches it very closely indeed. This curious beetle I found in more than one locality in Killarney, where (in Innisfallen Island) it was first discovered by Mr. Tardy. I also met with its larvæ, hitherto undescribed, and sent a number of specimens to the British Museum. I may also note that this beetle comes to sugar after dark, as do many of the Rhyncophora.

I cannot close my report without acknowledging the kind courtesy of Lord Kenmare in permitting me access with certain restrictions to his forests: and of Mr. Hussey, who gave me similar privileges on Mr. Herbert's property and Mucross Demesne.

A LIST OF SOME OF THE LEPIDOPTERA OBSERVED AT KILLARNEY AND ELSEWHERE IN THE SOUTH OF IRELAND.

Abbreviations used.

K. = Killarney. (All without locality appended are from this district.)

Gl. = Glandore, Co. Cork. (All these were taken by Charles Donovan, Esq., F.E.S., and identified by myself.)

Cap. = Cappagh, near Lismore, Co. Waterford.

v. ab. = very abundant.

RHOPALOCERA.

Euchlöe cardamines. Generally ab.
Colias edusa. A few occurred this year in the counties of Waterford, Wexford, and Cork.
Gonepteryx rhamni.
Argynnis paphia. Ab.
A. aglaia. Near Desertserges, Co. Cork.
Melitæa aurinia. Near Glandore, and v. hibernica.
Vanessa io. Ab., and at Glengariff.
V. cardui. Ab. in the south of Ireland generally.
Epinephile tithonus. K., Cap., and south of Ireland generally.
Cœnonympha typhon. Killarney specimens characterized by diminutive and few ocelli.
Thecla rubi. V. ab.
Lycæna argiolus. V. ab.

HETEROCERA—SPHINGES.

Sphinx convolvuli. Gl.
Smerinthus ocellatus. Gl. and Waterford.
Chærocampa elpenor. Not rare.
Macroglossa bombyliformis. K. and Gl.

BOMBYCES.

Sarothripus undulanus, v. degeneranus. With very pale ground colour.
Nemeophila russula. Ab.
Spilosoma mendica. One ♂ specimen at Glandore, coloured almost as pale as a ♀.
Pterostoma palpina. One specimen, Mucross Demesne.
Notodonta chaonia. Two specimens.
Cymatophora fluctuosa.
Demas coryli.
Acronyctia leporina.
Nonagria arundinis. Gl.

Mamestra persicariæ. Gl.
Stilbia anomala. Cap.
Rusina tenebrosa. Ab.
Agrotis saucia. Gl.; not rare.
Pachnobis rubricosa. Ab.
Tæniocampa gothica, v. Gothicina. Very striking examples.
—— gracilis.
—— pulverulenta. A few specimens.
Orthosia lota. K. and Cap.; ab.
—— macilenta. K. and Cap.; ab.
Anchocelis pistacina. K. and Cap.; not ab.
—— lunosa. Gl.
Cerastis vacinii. V. ab., K. and Cap.
—— spadicea. Scarce.
Scopelosoma satellitia. Not v. ab.
Xanthia flavago Hb.
Calymnia trapezina. Not ab.
Dianthœcia cucubali. K. and Gl.
—— cæsia. Gl.
—— capsincola. Gl.
—— capsophila. Gl.
Hecatera serena. Cap.
Xylocampa areola.
Calocampa vetusta. Ab., K., Cap., and Gl.
—— exoleta. K., one specimen; Gl., do.
Xylina ornithopus. Not rare; K. and Kap., Gl.
—— socia. Do. do. do.
Erastria fasciana. Ab.
Bankia argentula. K., locally ab.
Hydrelia uncula.
Euclidia mi. Ab.
Bomolocha fontis. Not rare.

Geometræ.

Eurymene dolobraria. One in Mucross demesne.
Ellopia prosafriaria. Gl.
Himera pennaria. Ab.
Amphydasis betularia.
Boarmia repandata. A handsome variety, with the edges of the median band f. wg. strongly marked in black.
—— cinctaria. Not rare, and generally with white median band.
Tiphrosia consonaria. Not rare.
—— crepuscularia and biundularia. Ab.
—— punctulata. Scarce.
Geometra papilionaria. Gl.
Venusia cambrica.

Acidalia immutata.
—— remutata. Ab.
—— inornata. Scarce.
—— margine punctata. Gl.
Bapta temerata. Not rare.
Macaria notata.
Panagra petraria. Locally ab.
Selidosema ericetaria. Gl.
Aspilates strigillaria. V. ab.
Ligdia adustata. Scarce.
Lomaspilis marginata. Ab.
Hybernia marginaria. Ab.
—— defoliaria. Ab.
Oporabia dilutata. Very strongly marked forms; v. ab.
Emmelesia albulata.
—— adæquata.
Eupithecia venosata. Melanic coloration. Gl.
—— pulchellata.
—— satyrata, v. callunaria.
—— castigata.
—— fraxinata. One specimen.
—— nanata. V. ab.
—— vulgata. V. ab.
—— abbreviata. Ab.
—— exiguata.
—— pumilata. Ab.
—— coronata.
—— debiliata.
Lobophora sexalisata. Scarce.
—— viretata.
Melanippe hastata. Not rare.
—— tristata. Cap.; ab.
—— unangulata. Cap.
Coremia designata. Not rare.
Eucosmia undulata. Gl.
Cidaria siterata. Mucross, v. ab.; Cap., Gl.
—— miata. Not ab.
—— suffumata. Ab.

Pyralides.

Scoparia ambigualis. V. ab.
—— dubitalis.
—— cratægella. Cap.

Pterophori.

Mimæscoptilus pterodactylus. Cap.

CRAMBI.

Crambus geniculens. Dursey I.

TORTRICES.

Sciaphila colguhounana. Dursey I.
Bactra lanceolana.
Pœdisca bilunana.
Ephippiphora similana.
—— pflugiana.
—— trigeminana.
Catoptria scopoliana.
Pleurota bicostella.
Acrolepia granitella. Cap.

XXXVI.—First Report on the Marine Fauna of the South-west of Ireland.

[Read, February 22, 1886.]

Introduction.

To Dr. E. Perceval Wright is due the credit of forming a Committee to investigate the Fauna of the hundred fathom line off the south-west coast of Ireland. Professor Wright brought the matter before the Royal Irish Academy, and obtained a grant for that purpose.

A preliminary list of names of naturalists who might constitute the Committee was then presented. From various circumstances this list was subsequently considerably modified, and, unfortunately, the Committee was also deprived of the active services of the Convener.

Most fortunately the Committee was able to secure the services of the Rev. W. S. Green, whose enthusiasm in dredging operations is unbounded. His practical and topical knowledge justified the Committee in leaving him to make all local arrangements, which the members of the expedition found to be satisfactory in every respect.

Mr. Green further enlisted the hearty co-operation of Mr. T. E. Weekes, the Chairman of the Queenstown Towing Company, who accompanied the expedition. Thanks are also due to Mr. W. H. W. Perrott, who undertook the mapping of the course of the vessel, and the plotting of the stations, and whose unfailing energy was always at the disposal of his colleagues.

The Committee was able to hire the well-known steamer, "Lord Bandon," of the Queenstown Towing Company, and it would here express its appreciation of the liberality with which that Company treated the Committee. The crew also entered heartily into the operations.

The *Lord Bandon* is a powerful tug steamer, with double, independent reversible engines. She is a very sea-worthy boat, and though some rough weather was experienced, scarcely a drop of water was shipped, and not a single bottle was upset. The ease with which she is handled render her peculiarly fitted for this class of work.

The party consisted of Professor A. C. Haddon, M.A., M.R.I.A., and H. W. Jacob, Esq., of Dublin; Joseph Wright, Esq., F. G. S., S. M. Malcomson, M.D., and W. Swanston, F. G. S., of Belfast; the Rev. W. S. Green, M.A., F.R.G.S., of Carrigaline; W. H. W. Perrott, Esq., B.A., now of the Royal Artillery, of Monkstown, Co. Cork. Professor Darcy, W. Thompson of Dundee, and J. Marsh, Esq., of Belfast, also accompanied the expedition for the first two days.

The "Lord Bandon" started from Queenstown at 3·30, p.m., on Monday, August 3rd, 1885, and the dredging commenced at 5 o'clock

the next morning, forty-nine miles west of Cape Clear, in ninety fathoms. Various hauls of the dredge were made, but though the ground appeared to be rich, the roughness of the weather and the temporary disablement of the scientific staff prevented the results from being as satisfactory as could be wished. After dredging for about twenty-two miles (Station I.), active operations ceased about two o'clock, p.m., and an anchorage was made in Dursey Sound.

Next day, the mouth of Kenmare River and Ballinskellig Bay were dredged. The weather was calmer, and the members of the staff were able to prosecute their several duties.

On Thursday, August 5th, the anchorage in Ballinskellig Bay was left very early; breakfast was taken in the lee of the Skelligs, and soon after 10 o'clock the dredge was down at a depth of 120 fathoms, twenty-five miles W.N.W. (by compass) of Great Skellig. Several hauls of the dredges were made from 120–110 fathoms (Station V.). In the afternoon, dredging was conducted about twelve miles S.W. of the Skelligs in 79–70 fathoms. Anchorage was for a second time made in Dursey Sound.

Friday was devoted to dredging opposite the mouth of Bantry Bay and along Berehaven. The night was passed in Bantry Harbour, and Professor Haddon and Mr. Jacob were landed soon after daybreak the next morning.

The remainder of the party made four casts of the dredge along the south coast, and arrived at Queenstown on Saturday evening.

Professor Haddon and Mr. Jacob spent the following fortnight in Bantry Bay. The weather was at first very unsettled, and quite prevented any dredging. A week was spent at Castletown-Bere investigating the fauna of Berehaven.

Dredging Stations, and General Results.

STATION I.—Forty miles off south-west Ireland; lat. 51° 15′ N.; long. 10° 31′ W.

Log No. 1.—Forty miles W. (by compass) of Fastnet; depth 90 fathoms; sand.

Log No. 2.—About five miles N.E. of No. 1; depth 90 fathoms; sand.

Log No. 3.—Six miles N.E. of No. 2; depth 80 fathoms; sand, with broken and living shells.

Log No. 4.—About four miles N.E. of No. 3; depth about 30 fathoms; broken shells.

Log No. 5.—About four to six miles N.E. of No. 4; depth 75 fathoms.

This station presented us with the greatest number of interesting specimens, which, however, mainly came up in the dredge at Log No. 3. The bottom appears to be sandy, with broken and living shells, and patches of Pinna rudis in places, which latter were broken across the middle by the dredge passing over them, their rounded ends being mainly brought up. Unfortunately no fine material was obtained.

Gephyra dorhnii on tubes of Tubularia indivisa, Palythoa sp., Epizoanthus papillosus, commensal with Eupagurus excavatus and Spiropagurus lævis, Caryophyllia clavus, var. borealis. Ophiactis ballii, Ophioglypha lacertosa, large. Ophiothrix lütkeni, large. Echinus microstoma, Spatangus raschi. Lanice conchilega, Nothria conchilega.

In addition to the two species of Paguridæ just mentioned, were E. bernhardus and an undetermined species of hermit crab living in a Serpula-tube. Ebalia pennantii also occurred.

STATION II.—Dursey Sound.

Log No. 6.—South entrance to Dursey Sound; depth 25 fathoms; sand.

Log No. 7.—Dursey Sound; depth 25 fathoms; sand.

Log No. 8.—Dursey Sound; depth 20 fathoms; sand and large quantities of sea-weed.

Foraminifera rare. Textularia gramen and T. agglutinans, common. Ophiothrix pentaphyllum (7 and 8). Goniodoris castanea, G. nodosa, Triopa clavigera, Thecacera sp., Aplysia egg-coils only. The following Crustacea were trawled:—

Inachus dorsettensis, Portunus marmoreus, Corystes cassivelaunus, Atylus swammerdamii, Amathilla sabini, Gammarus locusta, Aora gracilis.

STATION III.—Mouth of Kenmare River.

Log No. 9.—In line between Dursey Sound and Lamb's Head, three miles from the Sound; depth 41 to 38 fathoms; mud.

Log No. 10.—Between Bull Rock and Skarriff, four miles from former; depth 47 to 44 fathoms; mud.

Log No. 11.—Two miles S.W. of Skarriff; depth 44 to 38 fathoms; muddy sand.

Log No. 12.—One mile S. of Skarriff; depth 40 fathoms; muddy sand and dead shells.

Log No. 21.—Between Bull Rock and Great Skellig, five miles from former; depth 48 fathoms; fine sand.

Foraminifera plentiful: Cornuspira foliacea, Thurammina papillata, Gaudryina filiformis, Sphæroidina bulloides, Pullenia quinqueloba, Pulvinulina micheliniana, Chilostomella ovoidea; Halcampa arenacea, sp. n. (11), Caryophyllia clavus, vars. borealis and smithii; C. cylindrica, Virgularia mirabilis (11); Astropecten irregularis, Luidia sarsii, Amphiura filiformis, Ophioglypha lacertosa, O. albida, Cucumaria pentactes (10); Amphictene auricoma (21), Owenia filiformis (21). Terebratulina caput-serpentis, rare; Crania anomala, common; Inachus dorsettensis, Ebalia cranchii, Spiropagurus lævis, Steiracrangon allmanni.

STATION IV.—Ballinskellig Bay.

Log No 13.—About one and a-half mile N.E. of Skarriff; depth 27 fathoms; bottom, stones and rocks. (Beam-trawl with two attached tow nets carried away, also two dredges fouled, and came up with only a few rounded stones.)

Log No. 14.—South end of Ballinskellig Bay; one mile N. E. of Hog's Head; depth 17 to 12 fathoms; stones.

Log No. 15.—North end of Ballinskellig Bay, about half a mile from shore; depth 5 fathoms; fine sand, with Zostera.

Foraminifera rare. Campanularia angulata. Usual common Echinoderms. Dentalium entalis, Loligo media.

STATION V.—About twenty-five miles W. N. W. of Great Skellig; lat 51° 46′ N.; long. 11° 13′ W.

Log No. 16.—Twenty-six miles W.N.W. (by compass) of Great Skellig; depth 120 fathoms; sand.

Log No. 17.—Three and a-half miles S. of No. 16; depth 110 fathoms; sand.

Foraminifera.—Most abundant, and of exceptional interest. A large quantity of the sea-bottem was brought up at Log. No. 17, in which one hundred and forty-three species and varieties were afterwards found—sixteen of these are new to Britain—besides many others which have been rarely met with off our coast. Echinodermata.—Ophioglypa affinis, not unfrequent, of small size; Echinus microstoma, common; Spatangus raschi, fragments. Vermes.—Niomache lumbricalis, Trophonia plumosa (?); Hyalinœcia tubicola, Owenia filiformis, and Lanice conchylega. Ostracoda.—Very scarce, many consisting of only a single valve; the most interesting are Cythere globulifera, Cytheropteron alatum, Loxoconcha fragilis, and Cytheridea sorbyana. It is somewhat remarkable that Cytheridea punctillata is here common, while the really much commoner C. papillosa is

very rare. These closely allied species are often found together. Malacostraca.—Nyctiphanes norvegica, Anonyx gulosus, Proto ventricosa, Triphosa longipes, and Eupagarus excavatus.

STATION. VI.—About twelve miles S. W. of Great Skellig.

Log No. 18.—Twelve miles S.W. of Great Skellig; depth 79 fathoms; sand.

Log No. 19.—Two miles N. W. of No. 18; same depth and bottom.

Log No. 20.—One mile or so E. S. E. of No. 19; depth 70 fathoms; muddy sand.

Foraminifera most abundant; the species very similar to those of Station V., Technitella legumen was obtained only here; Antennularia antennina, Aglaophenia pluma, and A. myriophyllum; Amphiura filiformis, Brissopsis lyrifer, Echinocardium flavescens, Thyone raphanus (20); Cerebratulus angulosus, Amphicteis gunneri (19). Galathea andrewsii, Corophium tenuicorne.

STATION VII.—Mouth of Bantry Bay.

Log No. 22.—Seven miles S. S. W. of Dursey Head; depth 40 fathoms; coarse sand.

Log No. 23.—Two and a-half miles E. of No. 22; depth 37 to 35 fathoms; coarse sand.

Foraminifera plentiful. Chitonactis (?) expansa sp. n. (22), Caryophyllia clavus, var. smithii; Virgularia mirabilis (23); Astropecten, irregularis, Luidia savignii, L. sarsii, Ophioglypha lacertosa, large, O. affinis, Spatangus purpureus, Echinocardium flavescens; Phyllodoce lamelligera, Nereis dumerilii, Hyalinœcia tubicola, Amphictene lauricoma, Pectinaria belgica, Lanice conchylega.

Remarkably fine specimens of the Ostracod Bythocythere constricta were abundant; the other Crustacea being Ebalia cranchii, Eupagurus lævis, Steiracrangon allmanni, Anonyx gulosus, Hippomedon hölbolli, Callisoma crenata, Astacilla longicornis.

Ascidia aspersa, A. virginea, pedunculated; Styela grossularia, on first; Molgula occulta (?) common; Eugyra glutinans; Polycarpa comata.

STATION VIII.—Berehaven.

Log No 24.—West entrance to Berehaven, close to Bere Island; depth 25 to 8 fathoms; coarse sand and broken shells.

Log No. 25.—Berehaven, from Volage Rock to Hornet Rock; depth about 5 fathoms; mud, sand, and stones.

Log No. 26.—Berehaven, S. of Beal Lough to George Rock; depth 7 fathoms; fine, dense mud.

The following is a summary of the results obtained by Professor Haddon and Mr. Jacob, after a more detailed examination of a portion of Berehaven:—

West entrance (log No. 24). The otter-trawl brought up thirty-two specimens of Echinus esculentus, mostly of large size, Echinocardium flavescens, Lineus marinus.

From Na-glas Point to Fort Point; depth 6 to 4 fathoms; bottom sand, mud and a few broken shells; dredges came up nearly empty, contained only a few common Hermit crabs and shells.

From Fort Point to Long Point; depth 7 to 3½ fathoms; bottom, broken shells, various Nemerteans and other worms, Eolis coronata on seaweed, &c.

From Colt Rocks to a little N. of Drum Point; depth about 8 fathoms; bottom mud, with seaweed. Not much except a few crustacea and scallops.

All the bottom to landward of the 5 fathom-line on the north side between Dinish Island and Hornet Rock is extremely poor dredging ground, consisting chiefly of rolled stones, with or without a coating of seaweed.

The channel included between the two 5-fathom lines has a uniform bottom of a dense adhesive mud, containing a few worms and echinoderms. In certain spots life is more abundant, this being notably the case in the 10-fathom depression, just off the White buoy at Volage Rock, where, especially a trifle to the east, is a collection of dead and broken shells which are often encrusted with Palythoa.

The following list will give some idea of the Fauna of this region of Berehaven:—

Cœlenterata—Several common Hydroids. Palythoa arenacea (?) and P. sp. Echinodermata, Antedon rosaceus, Asterias glacialis, A. rubens, A violacea, Amphiura chiajii, A. filiformis, Ophiocoma nigra, O. lacertosa, large size; O. albida, O. affinis, Ophiothrix pentaphyllum, Brissopsis lyrifer, large size; Echinocardium flavescens, Thyone fusus, T. raphanus, Ocnus lacteus, Synapta inhærens. Vermes—Eurylepta vittata, Amphiporus pulcher (?), Lineus marinus, Carinella annulata.

The only crustacea of any note were a small male of Nephrops norvegicus, Lysianassa spinicornis, and a few Amphipods.

Tunicata—Molgula occulta(?), Ascidia aspersa, A. mentula, Styela grossularia, S rustica(?), Clavelina lepadiformis, Leptoclinum maculatum, Morchellium argus, Diplasoma sp.

Volage Rock to Hornet Rock (log. No. 25), depth about 5 fathoms; bottom sand and mud. The otter-trawl brought up large numbers of Antedon rosaceus and its stalked larvæ. The two species of Amphiura were common round Hornet Rock. Sphenotrochus wrightii. Foraminifera plentiful, of species which usually occur in shallow water.

Common shallow water Ostracoda with Argillœcia cylindrica, Paradoxostoma orcadense, &c.

Ascidia mentula, A. aspersa, A. plebia, Styela grossularia, Morchellium argus, Botryllus sp.

Dredgings within the 5 fathom line on the south side of Berehaven, W. of Browra Rocks, gave no noteworthy results.

South of Beal Lough to George Rock (log. No. 26), depth about 7 fathoms; bottom dense mud. Only a few worms, common Molluscs, and Echinoderms, and numerous large common Ascidians, Ascidia aspersa, also Molgula occulta (?), Styela rustica (?) Clavelina lepadiformis, Morchellium argus, &c., were obtained.

Shore-collecting was undertaken when the tide permitted, but the results were not specially encouraging. By far the best collecting ground is the shore of the small promontory close by Dunboy House.

STATION IX.—Bantry Harbour.

Log. No. 32.—Bantry Harbour; depth 4 to 6 fathoms; mud.

The weather at Bantry Harbour was very unfavourable; and the muddy nature of the bottom—owing to the rocks of the coast being shales—prevents the fauna from being particularly rich or interesting. Various mud-burrowing worms, scallops, Bulla, and common ascidians (A. aspersa) were locally plentiful.

A day was devoted to visiting the caves on the north shore of the Bay between Sheelane Island and Shot Head, which have been so graphically described by Dr. E. P. Wright in Gosse's "Actinologia Britannica," pp. 64, 65. Unfortunately the tide was not particularly favourable, and a long day was only rewarded with the sight of a few specimens of the commonest European sea-anemones.

STATION X.—Long Island Bay.

Log. No. 27.—About three miles S. of Alderman Rocks; depth 30 fathoms; rocks.

No fine material brought up; dredge fouled frequently, and came up comparatively empty. A few pieces of rolled coral, living Caryophyllia, and dead Arca. One haul of the dredge (which fouled) contained only a few starfishes; one specimen of Luidia savignii measured 20 inches across.

STATION XI.—Off Baltimore.

Log. No. 28.—Two and a-half miles S. of the chapel on Sherkin Island; depth 30 fathoms; mud.

Foraminifera most abundant, especially the genera Polymorphina, Lagena, and Bulimina. Cucumaria pentactes.

STATION XII.—Nine miles S. of Glandore.

Log. No. 29.—Nine miles S. of Glandore; depth 40 fathoms; broken shells.

The dredge brought up no fine material. Gephyra dorhnii on tubes of Tubularia indivisa; Cucumaria pentactes; various worms, Terebratulina caput serpentis, rare; Crania anomala very common.

STATION XIII.—Twelve miles off Clonakilty Bay.

Log. No. 30.—About ten miles S. of Galley Head light; depth 54 fathoms; mud, sand and dead shells.

A number of rare Foraminifera were found at this station, viz., Planispirina celata, P. contraria, Trochammina trullisata, Textularia concava, Bigenerina digitata, B. nodosaria, Bulimina pyrula, B. buchiana, Cassidulina bradyi, Chilostomella ovoidea, Lagena crenata, Sphæroidina bulloides, etc. Craniaa momala, common. Dentalium entalis.

The Committee desire in this Report merely to give the actual results obtained, and designedly refrain from expressing any opinion concerning the nature and affinities of the marine fauna of the south-west of Ireland.

SPECIAL REPORTS.

The various groups have been distributed as follows:—

Foraminifera, ...	Joseph Wright, F.G.S.
Hydrozoa, ...	A. R. Nichols, B.A. (Hydroids), and Professor Haddon (Medusæ).
Malacozoa, ...	Professor A. C. Haddon, M.A., M.R.I.A., and S. O. Ridley (Zoanthidæ).
Hexacoralla, ...	S. O. Ridley, M.A., &c.
Echinodermata (part), .	Professor A. C. Haddon.
Holothuroidea, ...	Professor F. Jeffry Bell, M.A., &c.
Vermes, ...	Professor A. C. Haddon.
Polyzoa, ...	A. R. Nichols.
Brachiopoda, ...	W. Swanston, F.G.S.
Mollusca, ...	W. Swanston and Professor Haddon (Nudibranchiata).
Ostracoda, ...	S. M. Malcomson, M.D.
Copepoda, ...	S. M. Malcomson.
Amphipoda & Schizopoda,	Rev. Canon A. M. Norman, LL.D., &c.
Decapoda, ...	H. W. Jacob.
Tunicata, ...	Professor Herdman, D.Sc., F.R.S.E., &c.

Rhizopoda.

Foraminifera.

Most of the seventeen gatherings taken off the south-west of Ireland have already been microscopically examined for Foraminifera. Only one of them, however, (Station V., log No. 17, depth 110 fathoms) has been thoroughly exhausted, the others having been gone over in a somewhat superficial manner, but a sufficient quantity of the material has been glanced through to give a good general idea of the Foraminifera of this part of our coast. One hundred and sixty-nine species and varieties have already been identified; but as much of the examination remains to be done, it is probable that other forms will be added to the list. Station V., log. 17, yielded material of exceptional interest. One hundred and forty-three species and varieties were obtained at this place alone, the specimens being for the most part larger in size than those usually met with around our coasts: sixteen of them are additions to the British Fauna, and a number of the others have been rarely met with in Britain. No additional new British forms were found in any of the other gatherings. With the exception of Webbina clavata and Globigerina rubra, all the species found at log 17, new to Britain, were also met with at Station VI., log 18; 79 fathoms, a few miles nearer shore; many of them also occurred in the shallow water gatherings. Rev. W. S. Green, F.R.G.S., Carrigaline; Daniel O'Connell, Esq., Derrynane Abbey; and Rev. Alexander Delop, Valencia Island, kindly contributed shore gatherings from various localities.

List of Species.

Species marked (*) are new to the British Fauna.

Biloculina sphæra, d'Orb. Large typical specimens occur plentifully at Station VI., 79 fathoms; and Station V., 110 fathoms. Typical examples of this species are rarely met with off the British coast.

—— ringens, Lamk. Frequent.

—— depressa, d'Orb. Frequent.

Spiroloculina limbata, d'Orb. Frequent.

—— planulata, Lamk. Rare.

Miliolina trigonula, Lamk. Rare.

—— tricarinata, d'Orb. Rare.

—— oblonga, Mont. Rare.

Miliolina seminulum, Linn. Common. Most of the specimens found in the deep water gatherings approach in contour M. auberiana.

—— secans, d'Orb. Common in shore gatherings at Derrynane Harbour and Ballinskellig Bay.

—— tenuis, Czjzek. Rare.

—— subrotunda, Mont. Frequent, especially in the shallow water and shore gatherings.

—— bicornis, W. & J. Rare.

—— ferussacii, d'Orb. Rare.

—— ferussacii, d'Orb., var. approaching in contour M. sclerotica, Karrer. Rare.

—— agglutinans, d'Orb. Rare.

—— fusca, Brady. Rare in shore sand, Derrynane Harbour.

Ophthalmidium carinatum, Balkwill & Wright. Common at Station XI., off Baltimore; 26 fathoms.

Planispirina contraria, d'Orb. A few examples of this rare species were found at Station V., 110 to 120 fathoms; Station VI., 79 fathoms; and Station XIII., 54 fathoms.

*Planispirina celata, Costa. Rather rare at the following stations: Station V., 110 to 120 fathoms; Station XIII., 54 fathoms; Station VI., 79 fathoms; and Station III., 48 fathoms.

Cornuspira foliacea, Phil. Rare.

—— involvens, Reuss. Rare.

*—— carinata, Costa. Rare at Station V.; 110 to 120 fathoms; and Station VI., 79 fathoms.

*Bathysiphon filiformis, Sars. A few small specimens were found at Station V., 110 fathoms; and Station VI., 79 fathoms.

Psammosphæra fusca, Schultze. Good typical specimens. Frequent at the following stations: Station V., 110 fathoms; Station VI., 79 fathoms; and Station III., 48 fathoms. This species has been rarely met with off the British coast.

Technitella legumen, Norman. Rare at Station VI., 79 fathoms.

Hyperammina elongata, Brady. Rare at Station V., 110 fathoms; and Station VI., 79 fathoms.

Reophax fusiformis, Will. Frequent.

—— scorpiurus, Mont. Frequent.

Haplophragmium glomeratum, Brady. Rare.

—— globigeriniforme, P. & J. Rare.

—— pseudospirale, Will. Rare.

—— canariense, d'Orb. Rare.

Placopsilina cenomana, d'Orb. Small specimens, parasitic on shells, &c., were found at Station V., 110 to 120 fathoms. Only one recent example of this rare species has hitherto been recorded from Britain. It was found by Dr. Malcomson in a shore gathering, Belfast Lough.

Thurammina papillata, Brady. Rare at Station V., 110 fathoms; Station VI., 79 fathoms; and Station III., 38 to 41 fathoms. Only one recent example of this species has been hitherto met with in Britain. It was found off Loch Scavaig, on the west coast of Scotland, 45 to 60 fathoms.

Ammodiscus incertus, d'Orb. Rare.

—— gordialis, J. & P. Rare.

—— charoides, J. & P. Rare.

Trochammina squamata, J. & P. Rare.

—— macrescens, Brady. Rare at Derrynane Harbour, between tides.

—— inflata, Mont. Rare at Derrynane Harbour, between tides.

*—— nitida, Brady. Rather rare at Station V., 110 fathoms; Station VI., 79 fathoms; Station VII., 40 to 45 fathoms; and Station II., 48 fathoms.

*—— trullisata, Brady. Small specimens. Very common at Station V., 110 fathoms; Station VI., 79 fathoms; and Station XIII., 54 fathoms. "This beautiful little shell has been noted at twenty-five localities, pretty evenly scattered over the North and South Atlantic, the Southern Ocean, and North and South Pacific. Of these, only five have depths of less than 1500 fathoms, and fifteen are above 2000 fathoms."[1]

*Webbina clavata, J. & P. Rare at Station V., 110 to 120 fathoms.

*Textularia concava, Karrer. Large specimens. Found at six of the Stations; very common at Station V., 110 fathoms, and Station VI., 79 fathoms.

Textularia sagittula, Defrance. Frequent.

—— gramen, d'Orb. Common.

—— agglutinans, d'Orb. Frequent.

Bigenerina nodosaria, d'Orb. Very common at Station III., Station V., and Station VI.; very rare at Station XIII.

—— digitata, d'Orb. Very common at Station III., Station V., Station VI., and Station XIII.

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[1] Brady's *Rep. Challenger, Foraminifera*, p. 343.

Gaudryina filiformis, Berthelin. Rare.

Verneuilina polystropha, Reuss. Rare.

Valvulina fusca, Will. Found at five Stations. Common at Station V., 110 fathoms; and Station VI., 79 fathoms.

Bulimina elegans, d'Orb. Frequent at several of the Stations.

*—— pyrula, d'Orb. Found in nearly all the gatherings; very common at Station V., 110 fathoms.

—— pupoides, d'Orb. Common.

—— ovata, d'Orb. (*Will. Rec. For.*, pl. v., figs. 129, 130). Common.

—— elegantissima, d'Orb. Very rare.

—— subteres, Brady. Found in nearly all the gatherings; large typical specimens are common at Station V., 110 fathoms.

—— marginata, d'Orb. Common.

*—— buchiana, d'Orb. Frequent at Station V., 110 to 120 fathoms; rare at Station III., 48 fathoms; Station VI., 79 fathoms; and Station XIII., 54 fathoms.

Virgulina schreibersiana, Czjzek. Frequent.

Bolivina punctata, d'Orb. Rare.

—— dilatata, Reuss. Common.

—— textilarioides, Reuss. Frequent.

—— plicata, d'Orb. Rare.

—— difformis, Will. Frequent.

Cassidulina lævigata, d'Orb. Very common.

—— crassa, d'Orb. Rare.

—— bradyi, Norman. Rare in the shallow-water gatherings; common at Station V., 110 to 120 fathoms; Station VI., 79 fathoms; and Station XIII., 54 fathoms.

Chilostomella ovoidea, Reuss. Common at Station V., 110 fathoms; Station VI., 79 fathoms; and Station XIII., 54 fathoms; rare at Station III., 48 fathoms.

Lagena globosa, Mont. Very rare.

—— apiculata, Reuss. Rare at Station V., 110 fathoms; and Station VI., 79 fathoms.

—— lineata, Will. Rare.

—— lævis, Mont. Rare.

—— ——, var. clavata, d'Orb. Frequent.

—— gracillima, Seg. Rare. Fine typical specimens were found at Station V., 110 fathoms.

Lagena hispida, Reuss. Found in most of the gatherings. Common at Station V., 110 fathoms; and Station XIII., off Clonakilty Bay, 54 fathoms.

—— striata, d'Orb. Common.

—— curvilineata, Balkwill and Wright. One specimen at Station XIII., 54 fathoms.

—— gracilis, Will. Rare.

—— distoma, P. & J. Fine typical specimens were found at Station V., 110 fathoms.

—— sulcata, W. & J. Frequent.

—— costata, Will. One specimen at Station XI., 26 fathoms.

—— williamsoni, Alcock. Frequent.

—— semistriata, Will. Frequent.

—— semilineata, Wright.[1] Very rare at Station V., 110 fathoms.

—— crenata, P. & J. Frequent at Station V., 110 fathoms; and Station VI., 79 fathoms; rare at Station XIII., 54 fathoms.

—— squamosa, Mont. Rare.

—— hexagona, Will. Rare.

—— lævigata, Reuss. Rare.

—— ——, var. quadrata, Will. Very rare.

—— marginata, W. & J. Rare.

—— lagenoides, Will. Rare.

—— ——, var. tenuistriata, Brady. Very rare at Station XI., off Baltimore, 26 fathoms.

—— orbignyana, Seg. Common.

*—— ——, var. walleriana. Nov. var. A variety having the centre of the convex faces ornamented with a prominent boss. Found in several of the gatherings. Common at Station V., 110 fathoms; and Station VI., 79 fathoms.

Lagena bicarinata, Terquem. Rare.

—— fimbriata, Brady. Found at four of the Stations; very common at Station V., 110 fathoms. Mr. Brady,[2] speaking of the geographical distribution of this species, says:—"L. fimbriata is a rare variety, and affects very deep water; it has been noticed at three Stations in the North Atlantic, at one in the Southern Ocean, at three in the South Pacific, and at one in the North Pacific. Of these, two are respectively 580 fathoms, and 620 fathoms; the remaining six at depths 2300 fathoms, or more." It is also recorded by Messrs. Balkwill and Millett,[3] three specimens having been found by them in shore-sand on the coast of Galway.

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[1] *Proc. Belfast Nat. Field Club*, 1844–5; App. p. 320, pl. xxvi. fig. 7.
[2] *Rep. Challenger, Foraminifera*, p. 486.
[3] *Journal of Microscopy and Natural Science*, iii. 1884.

Nodosaria (Glandulina) lævigata, d'Orb. Rare at Station V., 110 to 120 fathoms.

*—— (Glandulina) rotundata, Reuss. Common at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms.

—— radicula, Linn. One specimen at Station V., 120 fathoms.

—— pyrula, d'Orb. Rare.

—— (D.) pauperata, d'Orb. One specimen at Station V., 110 fathoms.

—— (D.) consobrina, d'Orb. Very rare.

—— (D.) communis, d'Orb. Frequent.

—— raphanus, Linn. Rare at Station V., 110 to 120 fathoms.

—— scalaris, Batsch. Frequent.

—— ——, var. separans, Brady. Found at three stations; common at Station V., 110 to 120 fathoms.

—— (D.) obliqua, Linn. Rare.

Marginulina glabra, d'Orb. Rare.

—— costata, Batsch. Rather rare at Station V., 110 fathoms; and Station VI., 79 fathoms.

*Cristellaria variabilis, Reuss. Rather rare at Station V., 110 fathoms.

—— crepidula, F. & M. Rare.

—— rotulata, Lamk. Rare.

—— cultrata, Montf. Rare at Station V., 110 to 120 fathoms.

Polymorphina lactea, W. & J. Frequent.

—— gibba, d'Orb. Frequent.

—— sororia, Reuss, var. cuspidata, Brady. Rather rare at Station V., 110 fathoms; Station VI., 79 fathoms; and Station XIII., 54 fathoms.

—— lanceolata, Reuss. Rare.

—— oblonga, Will. Rare.

—— compressa, d'Orb. Frequent.

—— concava, Will. Rare at Station V., 110 fathoms.

—— rotundata, Bornemann. Frequent at Station VI., 79 fathoms.

—— ——, fistulose form. Found at three of the Stations. Common at Station VI., 79 fathoms, the specimens being very fine.

—— myristiformis, Will. Frequent.

Uvigerina pygmæa, d'Orb. Large typical specimens. Common at Station V., 110 to 120 fathoms; Station VI., 79 fathoms; and Station XIII., 54 fathoms; rather rare at Station III., 38 to 48 fathoms.

—— angulosa, Will. Frequent.

—— canariensis, d'Orb. Very rare.

Globigerina bulloides, d'Orb. Common.

—— inflata, d'Orb. Found in nearly all the gatherings; large typical specimens abundant at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms.

*—— rubra, d'Orb. Small specimens; very rare at Station V., 110 fathoms.

*—— æquilateralis, Brady. Rare at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms; very rare at Station III.; mouth of Kenmare River, 48 fathoms.

Orbulina universa, d'Orb. Found in many of the gatherings; large specimens common at Stations V., 110 to 120 fathoms; and Station VI., 79 fathoms.

Pullenia quinqueloba, Reuss. Frequent at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms; very rare at Station III.; mouth of Kenmare River, 48 fathoms. Only one specimen of this species has hitherto been recorded from Britain; it was found off Dublin, 45 fathoms.

Sphæroidina bulloides, d'Orb. Large typical specimens. Common at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms; very rare at Station III., 48 fathoms; and Station XIII., 54 fathoms. This species has been rarely met with off the British coast.

Spirillina vivipara, Ehr. Rare at Station XI., 26 fathoms.

Patellina corrugata, Will. Rare.

Discorbina globularis, d'Orb. Frequent.

—— rosacea, d'Orb. Rare.

—— bertheloti, d'Orb. Found in most of the gatherings; common at Station V., 110 to 120 fathoms; and Stations VI., 79 fathoms.

Planorbulina mediterranensis, d'Orb. Frequent.

Truncatulina refulgens, Montf. Rare at Station V., 110 fathoms; and Station III., 40 to 48 fathoms.

—— lobatula, W. & J. Frequent.

—— ungeriana, d'Orb. Frequent at Station V., 110 to 120 fathoms and Station VI., 79 fathoms; very rare at Station III. mouth of Kenmare River, 48 fathoms.

Pulvinulina repanda, F. & M. Rare at Station III.; mouth of Ken mare River, 40 to 48 fathoms.

—— auricula, F. & M. Common.

Pulvinulina canariensis, d'Orb. Rare at Station V., 110 fathoms.

—— patagonica, d'Orb. Rare at Station V., 110 to 120 fathoms; and Station XIII., 54 fathoms.

—— karsteni, Reuss. Large typical specimens. Rather rare at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms.

*—— micheliniana, d'Orb. Frequent at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms; very rare at Station III.; mouth of Kenmare River, 48 fathoms.

—— elegans, d'Orb. Large specimens. Frequent at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms; rare at Station II., 15 to 25 fathoms; and Station III., 48 fathoms.

Rotalia beccarii, Linn. Frequent.

—— orbicularis, d'Orb. Rare at Station V., 120 fathoms.

—— nitida, Will. Rare.

Gypsina globulus, Reuss. One large specimen at Station V., 110 fathoms.

—— vesicularis, P. & J. One specimen.

—— inhærens, Schultze. Rather rare.

Nonionina depressula, W. & J. Common between tides and in the shallow water gatherings.

—— umbilicatula, Montf. Large typical specimens occur in most of the gatherings; very common at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms.

—— orbicularis, Brady. Frequent at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms.

—— stelligera, d'Orb. Rare.

—— scapha, F. & M. Large specimens very common at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms; very rare at Station III.; mouth of Kenmare River, 40 fathoms.

—— pauperata, Balkwill and Wright. Rare at Station XI., off Baltimore, 26 fathoms.

—— turgida, Will. Common.

Polystomella crispa, Linn. Rare.

*—— subnodosa, Munster. Frequent at Station V., 110 and 120 fathoms. Mr. Brady, in his Report on "Challenger" *Foraminifera*, p. 735, says: "As a living Foraminifer, Polystomella subnodosa has only been identified at two points, amougst the islands south-west of Papua, Station 187, off Booby Island; depth 6 to 8 fathoms; and Station 188, depth 28 fathoms."

—— striato-punctata, F. & M. Frequent.

Operculina ammonoides, Gron. Found in nearly all the gatherings; very common at Station V., 110 to 120 fathoms; and Station VI., 79 fathoms.

Hydrozoa.

The Hydroids are, for the most part, common and widely distributed forms. The following only were obtained:—Hydractinia echinata, Flem., Berehaven; Tubularia indivisa, Linn, Stations I. and XII.; Clytia johnstoni, Ald.; Obelia geniculata, Linn.; O. dichotoma, Linn.; and Campanularia flexuosa, Hincks; all from Berehaven. C. angulata, Hincks, Station IV., a comparatively local form; Halecium halecinum, Linn.; H. beanii, Johnst.; Sertularella polyzonias, Linn.; Sertularia pumila, Linn.; and S. operculata, Linn.; all from Berehaven. Antennularia antennina, Linn., Station VI. and Berehaven; Aglaophenia pluma, Linn., Berehaven; A. myriophyllum, Linn., Station VI.; a rather rare and deep water form.

Several kinds of Hydromedusæ were obtained, but not in the abundance or variety that was expected. The only interesting species was Laodice cruciata, Forsk (Cosmetira pilosella, Forb.), this being the first time it has been recorded from Irish waters. The only Scyphomedusæ seen were a mutilated specimen of Chrysaora hysoscella, Linn, in Berehaven, and numerous specimens of the violet variety of Aurelia aurita, Linn., at Station VI., where also the only example of the Siphonophora was met with, which was, however, too imperfect to identify.

Of the Ctenophora, Pleurobrachia (Cydippe) pileus (?) and Beroe ovata were exceedingly common. Numerous specimens, Mnemia norvegiæ, Sars. (= Bolina hibernica, Patt.).

Actinozoa.

Malacozoa.

The following sea-anemones were found to be common in Bantry Bay:—Actinia equina, Linn., var. hepatica; vars. rubra, umbrina, and prasina were common on Bere Island, as were also the vars. sindonea and rubida (pink), of Actinoloba dianthus, Ellis. Tealia crassicornis, O. F. Müll., was everywhere distributed, and Anthea cereus was very common all along the Bay, growing especially on Zostera, etc., the flesh-coloured variety of smaragdina being especially abundant. Heliactis bellis, Ellis, is also very common, and is subject to considerable variation in colour. Careful notes were made of a translucent white sea-anemone from Dursey Sound, which may be a variety of Sagartia pallida, Holdsw. The chief difference between our form and S. pallida consists in the acontia being "emitted from the mouth in some abundance, but not very readily" in the latter, whereas in the former the acontia are emitted freely when irritated through lateral apertures (cinclides), a distinction which is of some importance.

Three additions have been made to the British Fauna, viz:—Halcampa arenacea, sp. n., from the mouth of Kenmare River (log No. 11), about seven and a-half miles N. E. of Dursey Head; depth 44 to 38 fathoms; bottom muddy sand. Column divided into physa, scapus, and capitulum; physa small, apparently without suckers, completely retractile; scapus cylindrical, even when extended, very contractile, sprinkled with imbedded grains of sand; capitulum elongated when fully extended; completely retractile. Tentacles, 12, marginal, monocyclic, cylindrical, obtuse, about as long as diameter of disc. Disc flat. Mouth linear. Colour—physa transparent, almost colourless; scapus pale, dull, madder brown; capitulum translucent, dirty flesh-colour. Tentacles of same colour as capitulum, with 4 imperfect pale brown bands and a basal M-mark. Disc pale, flesh-colour, with 12 pale mesenterial lines; at the base of each tentacle is a pair of narrow wedge-shaped pale-brown marks, the apices of which point towards the mouth, and between each of these and the latter is a lenticular pale-brown spot, which with its fellows form a ring round the mouth, and separated from it by a short interval. Mouth brownish. Length about 35 mm. in the ordinary condition: can contract to about 18 mm. Diameter variable; average about 7 mm. This species differs in a most marked manner from the only other known British, or, indeed, North European species of Halcampa (*cf.* Note on Halcampa chrysanthellum, Peach, *Proc. Roy. Dub. Soc.*, 1886 (N. S.), v. p. 1, figs. 1 to 4). It is also distinct from the North-east American forms. The number and arrangement of the mesenteries of this species agree perfectly with that which I have recently demonstrated for H. chrysanthellum (*l.c.* fig 4).

Gephyra dorhnii, Von Koch. This pretty pink anemone was first described and figured in the *Morphologische Jahrbuch*, IV., Suppl., 1878 (p. 74, pl. v.), from the Bay of Naples. The "Travailleur" expedition dredged it from the Bay of Biscay in 1881. Marion says it is more brilliant in colour than the Mediterranean individuals, and also a little larger in size (*Comptes rendus*, 1882, p. 458, and *Ann. Mag. N.H.* (5) IX., 1882, p. 334). We obtained several specimens on Tubularia indivisa from Stations I. and XII., at a depth of 80 fathoms; sand and broken shells. The colour was brighter than the Mediterranean species, but they were rather smaller in size. In the Gulf of Naples it grows upon Gorgonia, Isis, &c, and Andres states that a spotted variety is found in deeper water (150 mtr.) attached to Antipathes. (*Fauna und Flora, Golfes von Neapel.*, 1883, p. 166). In the Bay of Biscay it was also found on Isis; in the south of Ireland it has to content itself with the stems of Tubularia indivisa. The Rev. W. S. Green states that he has several times met with this form between Cork and Youghal.

Chitonactis (?) expansa, sp. n., from the mouth of Bantry Bay (Log No. 22, about four miles S. of Dursey Island), 40 fathoms; coarse sand. Column; scapus usually very depressed and turban-shaped, but when weakly or dead, obtusely conical, corrugated; base

flattened out and much and variably extended in all directions, the edges crenulated by the insertion of the mesenteries, of which there are about 100; when dead the base is withdrawn. Capitulum short, crenulated, invisible when the animal is fully extended; when retracted it almost completely covers over the tentacles. Tentacles short, conical, tetracyclic, 48 in number (6 + 6 + 12 + 24). Disc perfectly flat. Mouth, with fairly prominent lips, round. The body was entirely covered with grains of sand and broken shells. Colour—base translucent buff; scapus flesh-coloured; capitulum translucent pink; the mesenteries of the primary cycle of tentacles marked by a pair of dead-madder triangular spots; the three intervening lobes having a pale yellow spot. Tentacles pale, with two rows of pale-brown spots. Disc dark sepia, with six pairs of radial cream-coloured lines, and six shorter pairs for the secondary tentacles, and with similarly-coloured spots in rows between the lines. Mouth deep madder-brown; lips paler. Diameter of base 21–25 mm.; diameter of scapus 12 mm.; diameter of disc 7 mm. Only one specimen of this remarkable anemone was dredged. It has some resemblance to Chitonactis coronata, Gosse (cf. *Actinolog. Brit.*, p. 202, pl. vii., fig. 4, and Fischer, *Nouv. Arch. Mus.*, x., 1875, p. 193), but differs in the absence of tubercles, and in many other characters. Marion, in the Paper alluded to above, records, but not describes, C. richardi, sp. n., var. A., on branches of Mopsea elongata, and var. B. free on mud, from the Bay of Biscay; and it is unsatisfactorily figured on pl. vii. of Filhol's *La Vie au Fond des Mers*, but no mention of it is made in the text. It is with considerable doubt that our species is relegated to the genus Chitonactis.

The family Zoanthidæ was represented by a few forms, but our knowledge of these creeping colonial Actiniæ is at present in such an unsatisfactory condition, that it is almost impossible to identify them with any degree of certainty. Palythoa arenacea (?) D. Ch., Stations I. to XII. and Berehaven, 10 fathoms. P. sp., a squat button-like form from last locality and Station I. Epizoanthus papillosus, Johnst., an erect species entirely encrusting shells inhabited by Spiropagurus lævis, Thomps., and Eupagurus excavatus, Herbst, three specimens from Station I.

Hexacoralla.

The very few corals obtained mostly belong to the genus Caryophyllia, C. clavus, Scacchi, var. borealis, Dunc, Stations I. and III. C. clavus, var. smithii, Stokes and Brod., Stations III., VII., XII. A worn and broken colony of C. cylindrica, Reuss, occurred at Station III. in 40 fathoms. Three specimens of Sphenotrochus wrightii, Gosse, were found in Berehaven; these are, undoubtedly, fresh specimens (cf. Gosse, *Actinologia Britannica*, p. 326).

Octactiniæ.

The only Octactinian dredged was Virgularia mirabilis, Lam; one young specimen was obtained from the mouth of Kenmare River, in 40 fathoms, and two from the mouth of Bantry Bay, in 36 fathoms.

Echinodermata.

In addition to Forbes' *Monograph*, the following Papers have been consulted:—The Rev. A. M. Norman's valuable Paper "On the Genera and Species of British Echinodermata," part i., Crinoidea, Ophiuroidea, Asteroidea; *Ann. Mag. Nat. Hist.* (3) xv., pp. 98–129, and a useful List by W. E. Hoyle; "A Revised List of British Ophiuroidea," *Proc. R. Phys. Soc. Edin.* viii., pp. 135–155.

Crinoidea.

Antedon rosaceus is very common in Berehaven on the 5-fathom slope between Volage Rock and Hornet Rock. The specimens were large in size and brilliant in colour. In size they resemble the Mediterranean specimens rather than those ordinarily found in British waters. A couple of specimens were sent to Dr. P. H. Carpenter, F.R.S., who found on them malformed pinnules, though without definite cysts (*Nature*, xxxiii., 1885, p. 8), which are due to a new encysting Myzostoma (*cf.* P. H. Carpenter, *Nature*, xxxii., 1885, p. 391).

The stalked larvæ, more especially the later stages, were very abundant on sea-weed (August 6th).

Asteroidea.

Astropecten irregularis, Penn., very few specimens, Stations III., VII., IX.; Luidia savignii, Aud. (= L. fragillissima, Forbes, two specimens, Station VII.); L. sarsii, Düb. and Kor. (= L. fragillissima, Forbes, 5-armed var.), fairly abundant, Stations III. and IV., of large size—one specimen is 6½ inches, and another 7¼ inches in diameter; Asterina gibbosa, Penn, Station IX.; Asterias glacialis, Linn., one specimen, Berehaven, 10 fathoms; A. rubens, Linn., generally distributed; greatest depth, 48 fathoms (Log No. 21); A. violacea, O. F. Müll, Dursey Sound and Berehaven.

Ophiuroidea.

Amphiura chiajii, Forbes (= Ophiocoma punctata, Forbes), Berehaven; mud, 5 to 12 fathoms; common, but not quite so abundant as the

following:—A. filiformis, O. F. Müll., Station III., 44 fathoms; VI., 75 fathoms; Berehaven, abundant, 5 to 12 fathoms; Bantry Harbour, rare; XII., 40 fathoms; A. elegans, Leech (= Ophiocoma neglecta, Forbes), between tides, Berehaven; Ophiactis ballii, Thomps. (+ Ophiocoma goodsiri, F.), Station I., 80 fathoms; Ophiocoma nigra, O. F. Müll., Berehaven, 5 to 12 fathoms, common; Ophioglypha lacertosa, Penn, Stations I., III., IV., VIII. The specimens from the first locality from 80 fathoms were of large size, the disc of the two largest measuring 29 and 33 mm. in diameter; two from Berehaven, 24 and 27 mm.; one from Station VII., 27 mm.; that of the largest specimen seen by Forbes was $\frac{9}{10}$ of an inch (23 mm.) in diameter. Wyville Thomson (*Depths of the Sea*, p. 100) also remarked on the large size this species attains off the S.W. coast; O. albida, Forbes, Stations III., VIII., IX.; O. affinis, Lütk., Station V., 120 to 110 fathoms; sand not unfrequent; of small size; VII., 40 fathoms; coarse sand, Berehaven. These are the first recorded Irish localities for this species. Ophiothrix pentaphyllum, Penn, Station II.; 25 to 20 fathoms; sand; a few young forms; VIII., 5 to 12 fathoms; not abundant. O. lütkeni, Wyv. Thoms., Station I., 80 fathoms. This beautiful species was first mentioned and named in Wyville Thomson's *Depths of the Sea*, p. 100, but it has never been described nor figured. It occurred off S. W. Ireland, lat 51° 1′ N., long 11° 21′ W., at 180 fathoms (Station 45a; second cruise of the "Porcupine," July 30, 1869). In the *Proc. Roy. Soc. Edin.*, 1883–84, xii., p. 710, Hoyle states that five specimens were obtained by the "Porcupine." The "Challenger" expedition dredged a young example from 450 fathoms; near the Azores, Station 75, lat, 38° 37′ N., long. 28° 30′ W., July 2, 1873. (Lyman, Report on the "Challenger" *Ophiuroidea*). The following are the only published descriptions of this species:—"A large species of Ophiothrix, coming near O. fragilis, but of much larger size; the disk in the larger specimens 25 mm. in diameter, and the span from tip to tip of the rays 275 mm. The colours of the disk are very vivid, purple and rose; and all the plates of the disk, and the dorsal plates of the arms, are studded with delicate spines" (*Depths of the Sea*, p. 100). "Large and similar to Ophiothrix fragilis, but with short, thin arm spines, high arched arms, and minute spines on upper arm-plates" ("Challenger" Report, p. 215). Hoyle, in his "Revised List of British Ophiuroidea" (*Proc. Roy. Phys. Soc. Edinb.*, VIII., p. 154), merely repeats the foregoing localities. Two specimens were dredged by the expedition; the disk of the larger specimen is 29 mm. in diameter; the length of the arms is 250 mm., thus making the span from tip to tip of the arms 525 mm.; the diameter of the disk of the smaller is 25 mm. As this species has never been figured nor fully described, it is proposed to supplement this deficiency in the final report. We may claim this fine species as being a characteristic inhabitant of the deeper water off the south-west coast of Ireland.

Echinoidea.

Echinus esculentus, Penn. Very abundant at the west entrance to Berehaven. E. microstoma, Wyv. Thoms. Common at Stations I. and V.; from 80 to 120 fathoms. This species was found in great numbers by the "Porcupine" all round this region. E. miliaris, Linn., Stations VIII. and IX. Echinocyamus angulosus, Leske; extremely abundant in Bantry Bay. Spatangus purpureus, Leske; several young specimens at Station VII., and fragments from a few other places. S. raschi, Lov.; two or three specimens from Station I., and fragments from Station V. Wyville Thomson dredged this species in the first cruise of the "Porcupine" 40 miles W. of Valencia, in 110 fathoms (*l.c.* p. 86). There is a specimen in the Science and Art Museum, Dublin, from Valencia, Co. Kerry, presented by Mr. E. Waller, and another from 30 miles off Shetland. Brissopsis lyrifer, Forbes; several ordinary sized specimens were obtained from Station VI.; of two specimens from Berchaven, 10 fathoms, one is 63 mm. ($2\frac{1}{2}$ inches) × 56 mm. ($2\frac{2}{10}$ inches, × 35 mm. ($1\frac{3}{8}$ inch). Forbes had a specimen $1\frac{3}{4}$ inch × $1\frac{3}{10}$ × 1 inch, but found fragments indicating larger dimensions; all his specimens were from the estuary of the Clyde; mud 10 to 15 fathoms. So far as I can discover, this species has only been obtained from the W. coast in Ireland. Echinocardium flavescens, O. F. Müll., Stations VI., VII., and VIII. This species occurs sparingly at different points round the British coasts.

Holothuroidea.

Cucumaria pentactes, O. F. Müll. Stations III. (No. 10), XI. and XII.

—— sp. juv., Station III.

Thyone fusus, O. F. Müll. Berehaven.

—— raphanus, Düb. et Kor. Stations VI. (No. 20), and VIII.

Ocnus lacteus, Forbes. Berehaven, 10 fathoms. The only point of interest lies in the specimens of Ocnus. As is well known, Professor Edward Forbes recognised two species, which he called Ocnus brunneus and O. lacteus; but a comparison of his description shows that these two species differ in nothing but colour. M. Th. Barrois, in his *Catalogue des Crustaces podophthalmaires et des Echinodermes recueillis à Concarneau* (8vo., Lille, 1882, p. 51), remarks that O. brunneus has never been recorded since the time of Forbes, and that it seems but to be a colour variety of O. lacteus. Dr. Lampert, in his lately published Monograph of the Holothurians, inclines to M. Barrois's view.

It is quite certain that in Berehaven specimens of Ocnus, coloured brown or white, are found living together. I, at any rate, am unable to detect any difference between them: it appears to me, therefore, that O. brunneus may well be regarded as a synonym of O. lacteus.

Also from Berehaven was found an Ocnus of elongated form: as it is represented by a single specimen, it is as well to suspend judgment as to its exact affinities.

Synapta inhærens, O. F. Müll. Berehaven, 10 fathoms.

Vermes.

Turbellaria.

Eurylepta cornuta, O. F. Müll. Shore, Dunboy, Berehaven. E. vittata, Mont. Berehaven, 10 fathoms; one large specimen; and other unnamed "Planarians."

Nemertea.

Amphiporus pulcher (?) Johnst. Berehaven; 10 fathoms. Nemertes neesii, Œrst. Shore, Dunboy; numerous. Lineus marinus, Mont. Berehaven and Bantry Harbour. A large, very brittle, whitish Nemertean, with a pinkish head, was dredged at Stations III. and VI.; it is probably Cerebratulus angulatus, O. F. Müll. The anterior portion of a Nemertean was dredged in Berehaven; it probably belongs to the genus Micrura. It was 35 mm. long, and 2 mm. broad; flattened, head slightly swollen, gradually tapering anteriorly; trunk of body produced on the sides into a thin band, really forming a continuous lateral fin; no eyes were detected; a large lateral cephalic groove, distinctly red at the wide posterior end; colour dull pale, creamy orange, irregularly sprinkled with burnt sienna spots, which are more numerous at the anterior end; cephalic ganglia shine through with a marked rosy colour. If this species should prove to be new, the specific name of Pardalis would be appropriate for it. Carinella annulata, Mont., Berehaven.

Chætopoda.

The following Chætopods have been identified up to the time of going to Press:—

Aphrodite aculeata, Linn. Station XI.

Amphicteis gunneri, M. Sars. Station VI. (19).

Amphictene auricoma, Müll. Stations III. (21), VII. (22), VIII.

Cirratulus tentaculatus, Mont. Bantry Harbour.
Hyalinœcia tubicola, Müll. Stations V. (17), VII. (22).
Lanice conchilega, Pall. Bantry Bay, Stations I., V.
Nereis dumerilii, Aud. et M. Edw. Bantry Bay.
—— lobulata Rathke. Bantry Harbour.
—— pelagica, Linn. Berehaven.
Niomache lumbricalis, Fabr. Station V.
Nothria conchylega, Sars. Station I.
Owenia filiformis, D. Ch. Stations III., V., IX.
Pectinaria belgica, Pall. Bantry Bay.
Pista cristata, Müll. Berehaven.
Phyllodoce lamelligera, Turt. Bantry Bay.
Sabella pavonina, Sav. Station III. (21).
Syllis cornuta, Rathke. Berehaven.
Terebellides strœmi, Sars. Bantry Bay.
Tomopteris scolopendra, Quoy et Gaim. Station VI. (surface).
Trophonia plumosa (?), Müll. Station V.

Gephyrea.

Several examples of the typical form of Phascolion strombi, Mont., occurred at Station I. in dead shells of Apporhais pes-pelecani, also a single specimen of the variety S. dentalii, Grey, in the shell of Dentalium striata. This is the Sipunculus bernhardus of Forbes.

Polyzoa.

Eucratea chelata, Linn.; Scrupocellaria reptans, Linn, Berehaven; Cellaria sinuosa, Hass., Station VI.; Membranipora catenularia, Jameson, Station I.; M. pilosa, Linn; and M. membranacea, Linn., Berehaven; Microporella malusii, Aud.; and Schizoporella linearis, Hass., Station I.; Porella compressa, Sow., Berehaven; Mucronella coccinea, Abildg., Station I.; Cellepora ramulosa, Linn., Station XII.; Crisia cornuta, Linn.; C. eburnea, Linn.; and Pedicellina cernua, Pall., Berehaven.

Brachiopoda.

Terebratulina caput-serpentis, Linn. Station III., very rare; Station XII., rare.

Crania anomala, Müll. Station III., very common; Station XII., very common; Station XIII., common.

Mollusca.

During the cruise the larger shells brought up were carefully collected; the results were, however, disappointing, considering the number of hauls taken by both dredges and trawls. This was, perhaps, due to the nature of the bottom examined being principally sand or mud, or, as frequently happened, rocky, in which latter case the dredges fouled badly and came up empty. The sand and mud brought home for microscopic examination proved to be rich in the smaller forms, and advantage was taken of the necessary washing and sifting of this material to secure them. Mr. Joseph Wright—on whom this great labour falls—handed over to me the result of these washings, twenty-one packets of the coarse material. The material from Station V.—the deepest water dredged on the cruise—has yielded a number of very minute shells, which have been forwarded to Rev. A. M. Norman, M.A., who has kindly consented to verify them.

A tabulated list is appended, representing in all 133 species, a smaller number than might have been expected. In addition, there still remains some material from several of the stations not yet fully examined; also several critical species which remain for more satisfactory identification.

[*For Tabulated List, see over.*

LIST OF TESTACEOUS MOLLUSCA.

LAMELLIBRANCHIATA.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
LAMELLIBRANCHIATA.													
Anomia ephippium, Linn., . .	r.	r.	c.	..	..	..	..	..	..	..	..	..	..
,, patelliformis, Linn., . .	..	..	..	..	..	..	..	r.	..	..	..	c.	c.
Pecten maximus, Linn., . . .	..	..	c.	..	..	..	..	r.	..	..	..	..	..
,, opercularis, Linn., . .	c.	..	..	..	..	..	..	r.	..	..	c.	c.	c.
,, pusio, Linn., . . .	c.	..	..	..	..	f.	f.	c.	..	..	..	..	f.
,, similis, Lask., . . .	..	..	..	..	..	c.	r.	..	..	..	..	..	..
,, tigrinus, Müll., . .	..	..	r.	..	..	..	r.	..	..	..	..	..	..
Lima subauriculata, Mont., . .	..	v. r.	..	..	..	..	v. r.	..	..	..	..	..	..
,, loscombii, G. B. Sow., .	..	..	..	..	..	..	..	..	..	..	v. r.	..	..
Mytilus edulis, Linn., . . .	..	..	..	..	..	..	r.	..	..	..	..	..	..
Pinna rudis, Linn., . . .	c.	..	..	..	..	..	..	..	..	..	..	..	..
Nucula nucleus, Linn., . . .	..	..	c.	f.	..	..	..	f.	..	..	r.	..	f.
Pectunculus glycymeris, Linn., .	..	..	..	..	..	..	..	r.	..	..	..	..	r.
Arca tetragona, Poli., . . .	..	..	..	..	..	..	..	v. r.	..	..	r.	..	c.
Lucina spinifera, Mont., . .	..	..	..	r.	..	..	r.	f.	..	..	..	..	..

,, borealis, Linn., . .	r.	:	:	r.	:	:	:	f.	:	:	:	:	:
Axinus flexuosus, Mont., . .	:	:	r.	:	:	:	r.	:	:	:	:	:	:
Cardium echinatum, Linn., . .	r.	:	f.	:	:	:	f.	c.	:	:	:	:	:
,, edule, Linn., . .	:	:	:	:	:	:	:	r.	:	:	:	:	:
,, norvegicum, Spengl., . .	:	:	:	:	:	:	:	c.	:	:	:	:	:
,, papillosum, Poli., . .	:	:	:	:	:	r.	:	:	:	:	:	:	:
Astarte sulcata, Da Costa., . .	r.	r.	:	r	:	:	:	:	:	:	:	:	r.
,, triangularis, Mont., . .	:	v. c.	:	c.	:	:	v. c.	v. c.	:	:	:	:	:
Venus exoleta, Linn., . .	:	:	:	:	:	:	:	v. c.	:	:	:	:	:
,, lincta, Pult., . .	:	:	r.	:	:	f.	f.	c.	:	:	r.	:	:
,, fasciata, Da Costa., . .	:	:	:	:	:	:	:	f.	:	:	:	:	r.
,, gallina, Linn., . .	:	:	:	:	:	:	:	c.	:	:	f.	:	:
,, ovata, Penn., . .	r.	r.	:	:	:	:	f.	c.	:	:	:	:	r.
,, verrucosa, Linn., . .	:	:	:	:	:	:	:	r.	:	:	:	:	:
,, casina, Linn., . .	:	:	:	:	:	:	:	r.	:	:	:	:	:
Tapes virgineus, Linn., . .	:	:	:	:	:	:	:	c.	:	:	:	:	:
,, decussatus, Linn., . .	:	:	:	:	:	:	:	c.	:	:	:	:	:
Lucinopsis undata, Penn., . .	:	:	:	:	:	:	:	c.	:	:	:	:	:
Tellina crassa, Gmel., . .	:	:	:	:	:	:	:	f.	:	:	:	:	:

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Tellina pusilla, Phil.,	..	r.	..	..	..	..	r.	f.	..	..	..	..	..
Psammobia tellinella, Lam.,	..	..	..	..	..	..	r.	c.	..	..	..	..	..
,, ferröensis, Chann.,	..	..	..	..	..	..	f.	c.	..	..	..	..	..
Donax vittatus, Da Costa,	..	..	..	..	..	..	..	c.	..	..	..	..	..
Mactra solida, Linn.,	..	..	..	..	..	..	..	r.	..	..	..	..	..
,, ,, var. elliptica,	..	..	..	..	..	..	f.	c.	..	..	..	..	..
Lutraria elliptica, Lam.,	..	..	..	..	..	..	..	c.	..	..	..	..	..
Scrobicularia prismatica, Mont.,	..	r.	..	..	..	r.	r.	r.	..	..	..	..	..
,, nitida, Müll.,	..	r.	..	..	..	r.	..	r.	..	..	..	..	..
Solen pellucidus, Penn.,	..	..	..	..	..	..	r.	r.	..	..	..	..	..
,, ensis, Linn.,	..	..	..	..	..	..	..	c.	..	..	..	..	..
,, siliqua, Linn.,	..	..	..	..	..	..	..	c.	..	..	..	..	..
Pandora inæquivalvis, Linn.,	..	..	r.	..	..	r.	..	..	..	..	..	..	..
Thracia papyracea, Poli.,	..	..	..	..	..	..	..	c.	..	..	..	..	..
Næra abbreviata, Forbes,	..	..	..	..	..	v. r.	..	..	..	..	..	..	..
Corbula gibba, Oliva.,	..	..	..	..	..	r.	r.	r.	..	..	..	..	c.
,, var. rosea,	..	..	..	..	..	r.	..	..	..	..	..	..	..

Mya truncata, Linn.,	..	..	..	..	..	..	..	r.	..	..	..	..	..
Saxicava rugosa, Linn.,	..	..	..	..	..	..	..	r.	..	..	..	..	..
var. arctica,	..	r.	r.	..	..	..	r.	r.	..	..	r.	..	r.
SCAPHOPODA.													
Dentalium entalis, Linn.,	c.	..	r.	r.	..	..	..	r.	..	..	..	..	r.
GASTEROPODA.													
Chiton ruber, Lowe.,	..	..	..	..	..	..	..	r.	..	..	..	..	..
,, cinereus, Linn.,	..	..	..	..	..	..	..	c.	..	..	..	..	..
Patella vulgata, Linn.,	..	..	..	..	..	..	..	c.	..	..	..	..	..
Tectura fulva, Müll.,	..	r.	r.	..	..	r.	f.	r.	..	..	..	..	..
Emarginula fissura, Linn.,	..	..	r.	..	..	..	..	..	..	..	..	r.	r.
,, crassa, J. Sow.,	..	..	r.	..	..	..	..	r.	..	..	..	..	..
Capulus hungaricus, Linn.,	..	v. young	..	v. young	..	..	..	r.	..	..	..	..	..
Trochus cinerarius, Linn.,	..	..	..	..	..	..	..	r. young	..	..	..	..	..
,, magus, Linn.,	..	..	..	..	..	..	..	f.	..	..	..	..	..
,, millegranus Phil.,	..	..	v. r.	..	..	..	..	..	..	..	..	..	..
,, zizyphinus, Linn.,	..	..	..	..	..	..	..	f.	..	..	r.	..	r.
,, umbilicatus, Mont.,	..	v. young	..	..	..	..	..	..	..	..	..	..	..
,, tumidus, Mont.,	..	..	..	..	..	..	..	..	..	..	..	..	r.

GASTEROPODA.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Rissoa albella, Loven.,	..	..	..	..	..	..	..	c.	..	..	..	..	..
,, lactea, Mich.,	..	..	..	..	..	..	..	v. r.	..	..	..	..	..
,, reticulata, Mont.,	..	r.	c.	..	..	c.	..	..	..	..	r.	..	r.
,, costata, Ad.,	..	..	..	..	..	..	..	r.	..	..	..	..	..
,, parva, Da Costa,	..	r.	..	r.	..	r.	c.	..	..	..	..	..	..
,, violacea, Desm.,	..	..	..	..	..	..	..	v. r.	..	..	..	..	..
,, costulata, Ald.,	..	r.	..	..	..	..	..	..	..	..	..	..	..
,, striata, Ad.,	..	v. c.	..	..	..	..	v. c.	v. c.	..	..	c.	..	..
,, vitrea, Mont.,	..	..	c.	..	..	..	v. r.	..	..	..	c.	..	..
,, pulcherrima, Jeffr.,	..	r.	..	..	..	..	v. r.	..	..	..	..	..	..
Phasianella pulla, Linn.,	..	..	..	..	..	..	..	r.	..	..	..	..	..
Lacuna divaricata, Fabr.,	..	..	..	c.	..	..	..	c.	..	..	..	..	..
Littorina obtusata, Linn.,	..	..	..	..	..	..	..	f.	..	..	..	..	..
Caecum trachea, Mont.,	..	..	..	..	..	..	r.	v. c.	..	..	..	..	..
,, glabrum, Mont.,	..	..	..	..	..	..	..	v. r.	..	..	..	..	..
Turritella terebra, Linn.,	..	..	f.	..	..	c.	..	c.	..	..	c.	..	..
Scalaria communis, Lam.,	..	..	..	..	..	..	..	r.	..	..	..	..	..

,, clathratula, Ad., . .	..	..	v. r.	..	..	..	..	..	..	..	..	..	r.
Aclis ascaris, Zurt., . . .	..	..	v. r.	..	..	..	v. r.	..	..	..	..	..	..
Odostomia conoidea, Brocchi, . .	..	..	..	..	..	..	r.	..	..	..	..	..	..
,, acuta, Jeffr., . . .	..	..	..	..	..	..	..	r.	..	..	r.	..	..
,, conspicua, Ald., . .	..	..	..	..	..	r.	..	..	..	..	..	..	..
,, unidentata, Mont., . .	..	..	c.	..	..	..	..	..	..	..	..	..	..
,, diaphana, Jeffr., . .	..	..	r.	..	..	..	..	..	..	..	..	..	..
,, interstincta, Mont., . .	..	..	..	..	..	f.	..	r.	..	..	..	..	..
,, spiralis, Mont., . . .	..	..	r.	..	..	..	..	f.	..	..	..	..	..
,, rufa, Phil., . . .	..	..	r.	..	..	r.	..	..	..	..	..	..	r.
,, scillæ, Scacchi., . .	..	..	r.	..	..	..	r.	..	..	..	..	..	..
Eulima distorta, Desh., . . .	..	v. r.	v. r.	..	..	..	v. r.	v. r.	..	..	..	..	..
,, bilineata, Ald., . . .	..	v. r.	..	..	..	..	..	v. r.	..	..	..	..	..
,, subulata, Donovan, . .	..	..	r.	..	..	..	..	..	..	..	..	..	..
Natica alderi, Forbes, . . .	..	..	r.	r.	..	..	..	f.	..	..	c.	..	..
,, catena, De Costa, . .	..	..	..	..	..	..	..	r.	..	..	..	..	..
,, sordida, Phil., . . .	..	..	..	..	..	..	..	..	..	..	c.	..	..
Velutina lævigata, Penn., . .	..	..	v. r.	..	..	..	..	..	..	..	v. r.	..	..
Aporrhais pes-pelecani, Linn., .	c.	..	r.	..	..	..	c.	e.	..	..	r.	r.	r.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
Cerithium reticulatum, Da Costa, .	..	..	..	..	..	..	c.	c.	..	..	c.	..	..
„ perversum, Linn., .	..	..	..	..	..	..	r.	c.	..	..	..	..	f.
Cerithiopsis tubercularis, Mont.,	..	r.	..	..	..	..	..	..	..	..	..	..	..
„ costulata, Möller, .	..	r.	..	..	..	..	..	..	..	..	..	..	..
Purpura lapillus, Linn., .	..	..	..	..	..	..	v. r.	r.	..	..	..	..	..
Buccinum undatum, Linn., .	..	..	c. young	..	..	..	..	c.	..	..	..	..	..
Trophon muricatus, Mont.,	..	..	..	..	..	r.	..	..	..	..	..	..	..
„ truncatus, Ström., .	..	..	r.	..	..	..	..	..	r.	..	..	..	..
Fusus antiquus, Linn., .	..	..	..	..	..	..	..	c.	..	..	..	..	..
„ gracilis, Da Costa, .	..	..	..	..	..	..	..	..	..	..	..	r.	..
„ propinquus, Ald., .	..	..	..	..	..	r.	..	r.	..	..	..	..	..
Nassa reticulata, Linn., .	..	..	..	..	..	r.	..	r.	..	..	..	..	..
„ incrassata, Ström., .	..	..	c.	..	..	..	..	r.	..	..	r.	..	r.
Defrancia gracilis, Mont., .	..	..	..	..	..	..	..	r.	..	..	..	..	..
„ teres, Forbes, .	..	..	..	..	..	..	r.	..	..	..	..	..	..
„ reticulata, Ren., .	..	..	v. r.	..	..	..	..	..	..	..	..	..	..
Pleurotoma brachystoma, Phil., .	..	..	..	..	..	..	..	r.	..	..	..	..	..

,, septangularis, Mont.,	..	..	r.	..	..	..	..	r.	..	..	..	..	..
Cypræa europæa, Mont.,	..	..	r.	..	..	..	..	..	..	..	..	..	..
Cylichna acuminata, Brug.,	..	..	r.	..	..	..	..	..	..	..	..	..	..
,, cylindracea, Penn.	..	..	c.	..	..	..	..	..	..	..	c.	..	..
,, nitidula, Loven.,	..	..	c.	..	..	..	..	..	..	..	c.	..	..
Utriculus mammillatus, Phil.,	..	r.	..	..	..	..	r.	r.	..	..	r.	..	..
,, truncatulus, Brug.,	..	r.	..	..	..	..	c.	r.	..	..	r.	..	..
Actæon tornatilis, Linn.,	..	..	r.	..	..	..	r.	..	..	..	..	..	..
,, var. bullæformis,	..	..	r.	..	..	..	..	..	..	..	..	..	..
Bulla utriculus, Brocchi.,	..	..	r.	..	..	..	..	..	..	..	..	..	..
Scaphander lignarius, Linn.,	..	..	r. young	..	..	..	..	..	..	..	..	..	..
Philine scabra, Müll.,	..	v. r.	c.	..	..	..	v. r.	v. r.	..	..	c.	..	..
Aplysia (egg coils only),	..	c.	..	..	..	..	...	r.	..	..	..	..	..

NUDIBRANCHIATA.

Goniodoris castanea, Ald. and Han. Dursey Sound. This rare species has previously occurred only at Salcombe Estuary, Devonshire, and Saltcoats, Ayrshire. G. nodosa, Mont. Dursey Sound; Triopa claviger, O. F. Müll. Dursey Sound; Thecacera, sp., Dursey Sound. A full description of this form will be given: it appears to be intermediate between T. capitata, A. & H., and T. pennigera; Doto coronata, Gmel., Bantry Bay, Eolis exigua, A. & H., Berehaven. The only other recorded Irish locality is from Dublin Bay (*Proc. Roy. Irish Acad.* (2) IV. Science, p. 529); but it is probably widely distributed, having been overlooked on account of its small size and inconspicuous colouration. Eolis coronata, Forbes, Berehaven. Two varieties of this species were obtained, both more or less orange in colour.

CEPHALOPODA.

Loligo media, Linn. Station IV., one specimen; Station VII., two specimens.

Crustacea.

OSTRACODA.

As all the dredgings have not yet been thoroughly examined for Ostracoda, the present list of species and details of distribution must be considered as very incomplete. Already sixty-seven species have been found, one of which, Kirthe glacialis, has not been previously recorded as occurring in the recent state; and, in addition to these, there have been four species discovered, which are believed to be new to science; but as only one example of each kind has been obtained, it is not desirable to speak with certainty until more specimens have been found.

Many of the species mentioned in this Report are found more or less abundantly all round the British Isles,[1] and, in this case, their distribution is not given. When, however, a species is not recorded from a particular district, but occurs round the rest of the coast, its absence from that district is noted. The great majority of the species occur as Post-tertiary fossils, but only two of them, Cythere jonesii and Cytheridea papillosa, have been found in Tertiary deposits.

I have to thank Dr. Brady for the trouble he has taken in determining some doubtful specimens for me, more especially as several of them were only single valves, and consequently more troublesome than perfect ones usually are.

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[1] I have taken most of the facts of distribution from a Paper "On the Distribution of British Ostracoda," by Messrs. Brady and Robertson, published in the *Annals and Magazine of Natural History;* but have also made use of Dr. Brady's *Monograph of the British Ostracoda*, and other works on the subject.

LIST OF SPECIES.

Argillœcia, G. O. Sars.

cylindrica, G. O. Sars. Frequent in Berehaven, 4 fathoms; extremely rare in deeper water at mouth of Bantry Bay; not found in the deepest gatherings. Recorded from Irish Sea, Belfast Lough, Norway.

Pontocypris, G. O. Sars.

mytiloides, Norman. In most of the gatherings, but not common.

Bairdia, M'Coy.

inflata, Norman. Rare; in Berehaven, 4 fathoms; common on the western, but rare on the eastern coasts of the British Isles.

Cythere, Müller.

pellucida, Baird. A few specimens in Berehaven, but none from deeper gatherings; extends from Norway and the Gulf of St. Lawrence to Mediterranean; very common in Britain.

tenera, Brady. Common in all the gatherings.

crispata, Brady. Rare; in Berehaven, 4 fathoms; common in Britain. It has been found in Hong Kong Harbour, Booby Island, and Port Jackson.[1]

viridis, Müller. Rare; in Berehaven, 4 fathoms.

albomaculata, Baird. Common in Berehaven, 4 fathoms; very common in Britain; extends from Norway to Mediterranean and Cape Verd.

convexa, Baird. Very common in Berehaven, 4 fathoms.

finmarchica, G. O. Sars. Only one valve found at Station VI., 79 fathoms; not very abundant in Britain; extends from Davis's Straits to Cape Verd and St Vincent.

limicola, Norman. Rare at Station V., 110 fathoms; it has not been found in any other gathering; rare, and not very generally distributed in Britain; found also in Baffin's Bay and Norway.

globulifera, Brady. A few specimens of this rare species have been found in some of the deeper gatherings, Stations V. and VI. Recorded from west of Ireland, south-east of England, Spitzbergen.

pulchella, Brady. A great many somewhat dwarfed specimens, apparently belonging to this species, were found in Berehaven, 4 fathoms; not found on the east and south of England, but recorded from Baffin's Bay and Holland.

robertsoni, Brady. Very common in Berehaven, 4 fathoms; frequent at the mouth of Bantry Bay, 40 fathoms; not yet found in any of the deeper gatherings; a common shallow-water species. It does not appear to extend to the northern parts of Scotland, though it has been found in Norway.

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[1] Report on "Ostracoda of 'Challenger' Expedition."

Cythere, Müller.

villosa, G. O. Sars. Very common in Berehaven, 4 fathoms.

concinna, Jones. Found in nearly all the deeper gatherings.

emaciata, Brady. Common in Berehaven, less so in deeper gatherings; not found on the east coasts of England and Scotland.

quadridentata, Baird. Common in Station V.; rare in Stations VI. and VII.

tuberculata, G. O. Sars. A few specimens in Stations V. and VI.

dunelmensis, Norman. Frequent, Station V.; an Arctic and north European species.

whiteii, Baird. Only one specimen from Station V. A somewhat rare species found in S.W. of England, Irish Sea, Belfast Lough, Gulf of St. Lawrence, Levant.

antiquata, Baird. Common.

jonesii, Baird. Frequent, except from shallow water.

fidicula, Brady and Robertson. A large number of somewhat immature specimens, apparently belonging to this species, were found in Berehaven. Recorded from Shetland and S.E. of England.

?semipunctata Brady. Very rare, Stations VII. and VIII. Although a rare species, it extends all round Britain, except towards the northern parts of Scotland.

Cytheridea, Bosquet.

papillosa, Bosquet. Rare; Station V.

punctillata, Brady. Common; Station V.

sorbyana, Jones. Very rare; Station V. Recorded from Irish Sea, Shetland, Gulf of St. Lawrence, Spitzbergen.

elongata, Brady. Common in Berehaven.

Eucythere, Brady.

declivis Norman. Common in nearly all the gatherings.

Kirthe, Brady, Crosskey, and Robertson.

glacialis, Brady, Crosskey, and Robertson. One or two specimens of this species have been found from 110 fathoms, Station V. It does not appear to have been previously recorded as occurring in the recent state, but has been found as a post-tertiary fossil in the boulder clay of Scotland and Norway.

bartonensis, Jones. Rare; Stations V. and VI.

Loxoconcha, G. O. Sars.

impressa, Baird. Common from Berehaven; an extremely common shallow water species.

granulata, G. O. Sars. Several specimens from Stations V. and VI.; not recorded from northern parts of Scotland, but found in Norway.

guttata, Norman. Common in all the gatherings.

multifora, Norman. Stations V., VI., VII.; more or less common.

tamarindus, Jones. Common in all the gatherings.

Looxconcha, G. O. Sars.
fragilis, G. O. Sars. Stations V. and VI.; a rare species in Britain and Norway.

Xestoleberis, G. O. Sars.
depressa, G. O. Sars. In most of the gatherings, but rare.
aurantia, Baird. Rare; Station VIII.

Cytherura, G. O. Sars.
concentrica, Brady, Crosskey, and Robertson. Two specimens in Station V. Only recorded from Shetlands and Gulf of St. Lawrence.
undata, G. O. Sars. Rare; Stations VII. and VIII.
striata, G.O. Sars. Rare in nearly all the gatherings.
cuneata, Brady. Common in Berehaven.
angulata, Brady. Rare; Station VII.
propinqua, Brady and Robertson. Common; Station VIII. Recorded from S.E. of England, and Belfast Lough.[1]
producta, Brady. Rare in most of the gatherings.
cornuta, Brady. One specimen; Station VIII.
fulva, Brady and Robertson. Very common; Station VIII. Recorded from Scilly Islands,[2] Belfast Lough.[1]
acuticostata, G. O. Sars. Rare in most of the gatherings.

Cytheropteron, G.O. Sars.
latissimum, Norman. Very common at Station VII., 40 fathoms; frequent in most of the other gatherings.
nodosum, Brady. Common.
alatum, G. O. Sars. Rare; Stations V. and VI. Recorded from Shetlands, Irish Sea, and Norway.
montrosiense, Brady, Crosskey, and Robertson. Rare; Stations V. and VI. Recorded from West of Ireland and Baffin's Bay.
punctatum, Brady. Stations V. and VI.; fairly abundant.
subcircinatum, G. O. Sars. Very common in Berehaven. Recorded from west of Ireland, south-west of England, and Belfast Lough.

Bythocythere, G. O. Sars.
constricta, G. O. Sars. Stations VII. and VIII., very common.

Pseudocythere, G. O. Sars.
caudata, G. O. Sars. One specimen at Station VI., 79 fathoms. Not very common, but widely distributed both in the northern and southern hemispheres.

Sclerochilus, G. O. Sars.
contortus, Norman. Station VIII., very rare.

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[1] *Proc. Belfast Nat. Field Club* (Appendix), 1885.
[2] *Ann. and Mag. Nat. Hist.*, ser. 4, vol. xiii.

Paradoxostoma, Fischer.
  variabile, Baird. Station VII., rare.
  orcadense, Brady and Robertson. Very common at Berehaven. Previously recorded from the Shetlands.
  abbreviatum, G. O. Sars. Rare at Berehaven.
  obliquum, G. O. Sars. Two specimens only at Berehaven.
  hibernicum, Brady. One specimen at Berehaven. Not found in the northern parts of Scotland.
  ensiforme, Brady. Rare at Berehaven.
  flexuosum, Brady. Rare at Berehaven.
Polycope, G. O. Sars.
  orbicularis, G. O. Sars. Station V., frequent.

Copepoda.

The Copepoda did not receive much attention. The following species only have as yet been identified:—Calanus finmarchicus, Gunn., very common; Metridia armata, Boeck, few; Dias longiremis, Lillj, rare; Centropages typicus, Kröy, rare; Anomalocera patersoni, Templ., in a gathering by itself; Peltidium interruptum, Goods., one specimen at Station IV. The first four species occurred in all the tow-net gatherings.

Malacostraca.

Of the Malacostraca dredged by the Expedition, the following species have been so far determined; amongst the remainder will probably be found some interesting species. Those marked with an asterisk (*) appear not to have been previously recorded from Ireland.

Amphipoda.

*Corophium tenuicorne, Norman. Station VI.
*Atylus swammerdamii, Sp. Bate. Station II.
*Hyale nilssonii, Rathke. Berehaven.
Amathilla sabini, Sp. Bate. Station II.
Urothœ elegans, Sp. Bate. Berehaven.
Mæra othonis, Sp. Bate. Berehaven.
Anonyx gulosus, Kröyer. Stations V., VII., and VIII.
*Hippomedon hölbolli, Kroy. Station VII.
*Lysianassa spinicornis, Costa. Berehaven. This species is new to the British Isles.
Dexamine spinosa, Leach. Berehaven.
Gammarus locusta, Fabr. Stations II. and VIII.
Proto ventricosa, Müll. Stations V. and VIII.
*Aora gracilis, Sp. Bate. Station II.
Hyperia galba, Mont. On Aurelia aurita, Station VI.
Amphithœ littorina, Sp. Bate. Berehaven.
Triphosa longipes, Sp. Bate. Station V.
Callisoma crenata, Sp. Bate. Station VII.

ISOPODA.

Næsa bidentata, Leach. Berehaven.
*Dynamene montagui, Leach. Berehaven.
„ rubra, Leach. Berehaven.
Cymodocea truncata, Leach. Berehaven.
Idotea tricuspidata, Desm. Berehaven.
„ linearis, Latr. Station IV.
Ligia oceanica, Linn. Bantry Harbour.
Astacilla longicornis, Westw. Station VII.

SCHIZOPODA.

Mysis chamæleon, J. V. Thomps. Berehaven.
Nyctiphanes norvegica, M. Sars. Station V., 120 fathoms.

DECAPODA.

Stenorhynchus rostratus, Linn. Berehaven.
Inachus dorsettensis, Penn. Dursey Sound and Kenmare River.
„ dorynchus, Leach. Berehaven.
Hyas coarctatus, Leach. Berehaven.
Eurynome aspera, Leach. Berehaven; female, with eggs. This specimen had not deposited its eggs before August; Bell states June as the period for deposition.
Xantho florida, Leach. Berehaven, Dunboy.
„ rivulosa, M. Edw. Berehaven, Dunboy; not so plentiful as X. florida.
Cancer pagurus, Auct. Berehaven.
Pirimela denticulata, Leach. Shallow water in Berehaven; rare.
Carcinus mœnas, Leach. Berehaven.
Portunus puber, Leach. Berehaven.
„ arcuatus, Leach. Berehaven; common.
„ depurator, Leach. Kenmare River and Berehaven.
„ marmoreus, Leach. Dursey Sound.
„ pusillus, Leach. Berehaven.
Ebalia cranchii, Leach. Kenmare River and Bantry Bay.
„ tuberosa, Penn. Station I.
Corystes cassivelaunus, Leach. Dursey Sound; part of a specimen.
Eupagurus bernhardus, Fabr. Common everywhere.
„ excavatus, Herbst., var. meticulosus, Roux. Station I., 90 fathoms; and V., 110 to 120 fathoms. According to J. R. Henderson (*in litt.*), this is a deep-water species in this country, and was described from the Shetland Islands by Rev. A. M. Norman as *Pagurus tricarinatus*.
Spiropagurus lævis, J. V. Thomps. Stations I., III., VII.
[Commensal with Epizoanthus.]
The specimens were dredged in 90 fathoms.

An examination of the foregoing Table shows the following relations between the coefficients of terrestrial radiation :—

$$n = 2{\cdot}686 - 0{\cdot}0262\,\theta_0,$$

$$p = 29{\cdot}18 \quad - 0.415\,\theta_0\,;$$

so that, finally, the radiation per hour (R) is found from the equation—

$$Rp + (\theta - \theta_0)^n = 0,$$

where n and p have the values given above.

XXXVIII.—OBSERVATIONS ON NOVA ANDROMEDÆ, MADE AT DUNSINK.

By SIR ROBERT S. BALL, LL.D., F.R.S.

[Read, May 24, 1886.]

PROFESSOR ASAPH HALL has recently published a series of observations of Nova Andromedæ, conducted with the object of seeing whether this star had a parallax.

I made with a similar object a series of observations last autumn and winter with the south equatorial at Dunsink. These I desire to place on record in the Academy. I used two amparum stars, of which the first was that also employed by Professor Hall.

From Nova Andromedæ to Star 10*th, mag. p.*

DATE.	DISTANCE.	POSITION-ANGLE.
Sept. 21, 1885,	110″·0	262° 0′
,, 30, ,,	110·6	261 6
Oct. 3, ,,	108·9	261 46
,, 27, ,,	109·0	262 41
,, 28, ,,	109·8	263 19
Nov. 4, ,,	109·9	262 17
,, 30, ,,	109·5	260 36
Dec. 1, ,,	109·7	261 22
,, 2, ,,	108·7	262 7
,, 7, ,,	109·8	260 47
,, 8, ,,	109·1	261 13
,, 9, ,,	108·3	261 35

From Nova Andromedæ to Star 11*th, mag. s. f.*

Sept. 3, 1885,	229″·7	156° 33′
Oct. 3, ,,	230·2	156 25
Nov. 4, ,,	—	156 17
,, 30, ,,	228·8	155 29
Dec. 1, ,,	228·3	155 35
,, 2, ,,	229·5	157 3
,, 9, ,,	229·4	156 36

XXXIX.—NOTE ON THE ASTRONOMICAL THEORY OF THE GREAT ICE AGE. By SIR ROBERT STAWELL BALL., LL.D., F.R.S.

[Read, May 24, 1886.]

THE following calculation has convinced me that Mr. Croll's theory affords an adequate explanation of the Ice age. I compute the total quantity of heat received by each hemisphere of the earth during summer and winter respectively as follows:—

Let $2H/a^2$ be the quantity of sun-heat falling perpendicularly on an area equal to the section of the earth at the mean distance a from the sun in the unit of time.

Let δ be the sun's north declination. Then the share received by the northern hemisphere will be

$$\frac{H}{a^2}(1+\sin\delta),$$

and by the southern

$$\frac{H}{a^2}(1-\sin\delta).$$

At the distance r, and in the time dt, the heat received in the northern hemisphere will be

$$\frac{H}{r^2}(1+\sin\delta)\,.\,dt;$$

but we have

$$r^2\,d\theta = h\,dt,$$

whence the expression becomes

$$\frac{H}{h}(1+\sin\delta)\,.\,d\theta;$$

but we have

$$\sin\delta = \sin\theta\,.\,\sin\epsilon,$$

where ϵ is the obliquity.

The total heat received by the northern hemisphere from the vernal to the autumnal equinox is

$$\int_0^\pi \frac{H}{h}(1+\sin\epsilon\sin\theta)\,.\,d\theta = \frac{H}{h}(\pi + 2\sin\epsilon).$$

We have thus the following theorem:—

Let $2E$ be the total sun-heat received in a year over the whole earth; then this is divided into shares as follows:—

$$\text{Northern hemisphere, summer, } E\frac{\pi + 2\sin\epsilon}{2\pi}.$$

$$\text{,, \quad winter, } E\frac{\pi - 2\sin\epsilon}{2\pi},$$

with identical expressions for the summer and winter in the southern hemisphere.

If we make $\epsilon = 23° 27'$ we find that the heat received during the summer (equinox to equinox) of each hemisphere is $\cdot 627\,E$, while the heat during the winter of each hemisphere is $\cdot 373\,E$. More briefly still. If each hemisphere receives in the year a quantity of sun-heat represented by 365 units, then 229 of these are during summer, and 136 during winter. These figures are independent of the eccentricity of the earth's orbit.

The length of the summer is defined to be the interval when the sun's centre is above the equator. The length will of course vary with the eccentricity and with the position of the equinoxes on the orbit. We need only take the extreme case where the line of equinoxes is perpendicular to the major axis of the orbit. The maximum difference between the length of summer and of winter is thus

465 days × eccentricity.

I take the maximum eccentricity of the earth's orbit to be

0·0745,

this being the mean of the values by Leverrier, Lagrange, and Stockwell (*see* Croll, "Climate and Temp.," p. 531), and, therefore, the greatest difference between summer and winter will be about 33 days, i.e. one season is 199 days, and the other is 166 days.

The total quantity of heat received during the year on each hemisphere is practically independent of the eccentricity; but the mode in which that heat is received at the different seasons will vary, and thus give rise to the following extreme cases:—

GLACIAL.

229\. Heat units spread over 166 days.
136\. Heat units spread over 199 days.

OR INTERGLACIAL.

229\. Heat units spread over 199 days.
136\. Heat units spread over 166 days.

We hence deduce the following where unity represents the mean daily heat for the whole year on one hemisphere.

GLACIAL.

Mean daily sun-heat in summer (short), .	1·38
Mean daily sun-heat in winter (long), . .	·68

INTERGLACIAL.

Mean daily sun-heat in summer (long), .	1·16
Mean daily sun-heat in winter (short), .	·81

PRESENT (NORTHERN HEMISPHERE).

Mean daily sun-heat in summer (186 days),	1·24
Mean daily sun-heat in winter (179 days),	0·75

These figures exhibit a thermal force of great intensity. The unit represents all the mean daily heat received from the sun by which the earth is warmed up from the temperature of space. The heat unit in fact maintains a temperature perhaps 300°, or even more, above what the earth would have without that heat. Each tenth of a unit may thus roughly be said to correspond to a rise or fall of mean temperature of 30° or more. The long winter of 199 days, when the average heat is only two-thirds of a unit, leads to the accumulation of ice and snow, which form the glacial epoch. The short winter of 166 days, where the temperature is ·06 of a unit above that of our present winter, presents the condition necessary for the mild interglacial epoch.

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(*Continued from page* ii. *of this Cover.*)

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[List on appplication.]

[*For continuation of List of Publications, see page* iii. *of this Cover.*]

XL.—ON SOME THEOREMS IN DETERMINANTS. By A. H. ANGLIN, M.A., F.R.S. (Edin.), &c.

[Read, April 12, 1886.]

[ABSTRACT.]

1. THE method employed to establish the general results being that of Mathematical Induction, the corresponding results in one or two particular cases are first noticed.

By definition

$$\frac{1}{(1-ax)(1-bx)(1-cx)} = 1 + h_1x + h_2x^2 + \ldots + h_nx^n + \ldots,$$

where h_n is the sum of the homogeneous products of a, b, c and their powers, all of n dimensions.

But also it may be shown that

$$\frac{1}{(1-ax)(1-bx)(1-cx)} = \frac{A}{1-ax} + \frac{B}{1-bx} + \frac{C}{1-cx},$$

where $$A = \frac{a^2}{(a-b)(a-c)},$$

similar expressions holding for B and C; and thus

$$\frac{a^2}{(a-b)(a-c)} \cdot (1-ax)^{-1} + \&\text{c.} = 1 + h_1x + h_2x^2 + \ldots + h_nx^n + \ldots$$

Expanding, reducing to the common denominator $(c-b)(a-c)(b-a)$, which $= a^2(b-c) + b^2(c-a) + c^2(a-b)$, and equating coefficients of like powers of x in both sides of this equation, we shall obtain a series of similar results, the general one of which is—

$$a^n(b-c) + b^n(c-a) + c^n(a-b) = (c-b)(a-c)(b-a)\,h_{n-2};$$

or, expressing in the form of determinants,

$$\begin{vmatrix} a^n, & b^n, & c^n \\ a, & b, & c \\ 1, & 1, & 1 \end{vmatrix} = \begin{vmatrix} a^2, & b^2, & c^2 \\ a, & b, & c \\ 1, & 1, & 1 \end{vmatrix} h_{n-2} = (abc)\,h_{n-2}, \qquad (1)$$

where (abc) denotes the second determinant, or the product of the differences of a, b, c taken two at a time.

The corresponding result, when the indices in the second row of the first determinant have any general value r, is then obtained by the application of the identity

$$h_{r-1} = ah_{r-2} + \frac{b^r - c^r}{b - c};$$

and it is shown that

$$\begin{vmatrix} a^n, & b^n, & c^n \\ a^r, & b^r, & c^r \\ 1, & 1, & 1 \end{vmatrix} = \begin{vmatrix} a^n, & b^n, & c^n \\ a, & b, & c \\ 1, & 1, & 1 \end{vmatrix} h_{r-1} - \begin{vmatrix} a^{n+1}, & b^{n+1}, & c^{n+1} \\ a, & b, & c \\ 1, & 1, & 1 \end{vmatrix} h_{r-2},$$

which, by (1),

$$= (abc) \begin{vmatrix} h_{r-1}, & h_{r-2} \\ h_{n-1}, & h_{n-2} \end{vmatrix}. \qquad (2)$$

2. Corresponding results are then obtained (by a process which will be exhibited in the general case) in the cases of four and five letters, making use of the results (1) and (2); and, for greater clearness, and in order to discover the law by which the results in the general case are formed, we will *state* the results in these two particular cases.

When four letters a, b, c, d are employed, it is shown that, h_n denoting the sum of the homogeneous products of a, b, c, d and their powers of n dimensions,

$$\begin{vmatrix} a^n, & b^n, & c^n, & d^n \\ a^2, & b^2, & c^2, & d^2 \\ a, & b, & c, & d \\ 1, & 1, & 1, & 1 \end{vmatrix} = (abcd)\, h_{n-3}. \qquad (3)$$

$$\begin{vmatrix} a^n, & \\ a^r, & \&c. \\ a, & \\ 1, & \end{vmatrix} = (abcd) \begin{vmatrix} r-2, & r-3 \\ n-2, & n-3 \end{vmatrix}, \qquad (4)$$

and

$$\begin{vmatrix} a^n, & \\ a^r, & \&c. \\ a^s, & \\ 1, & \end{vmatrix} = (abcd) \begin{vmatrix} s-1, & s-2, & s-3 \\ r-1, & r-2, & r-3 \\ n-1, & n-2, & n-3 \end{vmatrix}, \qquad (5)$$

where the symbol $(abcd)$ denotes

$$\begin{vmatrix} a^3, & b^3, & c^3, & d^3 \\ a^2, & b^2, & c^2, & d^2 \\ a, & b, & c, & d \\ 1, & 1, & 1, & 1 \end{vmatrix},$$

or the product of the differences of a, b, c, d, taken two at a time; and where in the determinants on the right-hand side of the equations the elements are in reality h's, but for convenience the suffixes only being written.

And further, in the case of five letters, a, b, c, d, e, it is deduced, with the aid of the preceding results (3), (4), and (5), that h_r denoting the sum of the homogeneous products of a, b, c, d, e, and their powers of n dimensions,

$$\begin{vmatrix} a^n, & b^n, & c^n, & d^n, & e^n \\ a^3, & b^3, & c^3, & d^3, & e^3 \\ a^2, & b^2, & c^2, & d^2, & e^2 \\ a, & b, & c, & d, & e \\ 1, & 1, & 1, & 1, & 1 \end{vmatrix} = (abcde)\, h_{n-4}. \tag{6}$$

$$\begin{vmatrix} a^n, & \\ a^r, & \&c. \\ a^3, & \\ a, & \\ 1, & \end{vmatrix} = (abcde) \begin{vmatrix} r-3, & r-4 \\ n-3, & n-4 \end{vmatrix}, \tag{7}$$

$$\begin{vmatrix} a^n, & \\ a^r, & \&c. \\ a^s, & \\ a, & \\ 1, & \end{vmatrix} = (abcde) \begin{vmatrix} s-2, & s-3, & s-4 \\ r-2, & r-3, & r-4 \\ n-2, & n-3, & n-4 \end{vmatrix}, \tag{8}$$

and

$$\begin{vmatrix} a^n, & \\ a^r, & \&c. \\ a^s, & \\ a^t, & \\ 1, & \end{vmatrix} = (abcde) \begin{vmatrix} t-1, & t-2, & t-3, & t-4 \\ s-1, & s-2, & s-3, & s-4 \\ r-1, & r-2, & r-3, & r-4 \\ n-1, & n-2, & n-3, & n-4 \end{vmatrix}, \quad (9)$$

where $(abcde)$ denotes

$$\begin{vmatrix} a^4, & . & . & . & e^4 \\ a^3, & . & . & . & e^3 \\ a^2, & . & . & . & e^2 \\ a, & . & . & . & e \\ 1, & 1, & 1, & 1, & 1 \end{vmatrix},$$

or the product of the differences of a, b, c, d, e taken two at a time; and the same remark applying to the right-hand determinants as in the preceding case.

3. We now proceed to establish corresponding results in the general case of any number (m) of letters $a, b, c, \ldots l$; and, in order to effect this, there will be a double application of the principle of Mathematical Induction—the first, by reference to the number of letters employed; and the second, by reference to the number of general indices in the case of any particular number of letters.

By definition

$$\frac{1}{(1-ax)(1-bx)\ldots(1-lx)} = 1 + h_1 x + \ldots + h_n x^n + \ldots,$$

where h_n denotes the sum of the homogeneous products of $a, b, c, \ldots l$, and their powers of n dimensions.

But it may also be shown that

$$\frac{1}{(1-ax)(1-bx)\ldots(1-lx)} = \frac{A}{1-ax} + \frac{B}{1-bx} + \ldots + \frac{L}{1-lx},$$

where

$$A = \frac{a^{m-1}}{(a-b)(a-c)\ldots(a-l)}, \quad \ldots, \quad L = \frac{l^{m-1}}{(l-a)(l-b)\ldots(l-k)};$$

and thus

$$\frac{a^{m-1}}{(a-b)(a-c)\ldots(a-l)} \cdot (1-ax)^{-1} + \ldots + \frac{l^{m-1}}{(l-a)(l-b)\ldots(l-k)} \cdot (1-lx)^{-1}$$
$$= 1 + h_1 x + h_2 x^2 + \ldots + h_n x^n + \ldots$$

Reducing the expression forming the left-hand member of this equation to its common denominator (which consists of the product of the differences of $a, b, c, \ldots l$, taken two at a time), we have

$$a^{m-1}(bcd\ldots l)(1-ax)^{-1}-b^{m-1}(acd\ldots)(1-bx)^{-1}+c^{m-1}(abd\ldots l)(1-cx)^{-1}$$

$$-\ldots+(-1)^{m-1}\,l^{m-1}(abc\ldots k)(1-lx)^{-1}$$

$$=(abc\ldots l)(1+h_1x+h_2x^2+\ldots+h_nx^n+\ldots), \qquad (A)$$

where any symbol of the form $(abc\ldots)$ denotes the product of the differences of the letters involved, taken two at a time.

We now, in accordance with the principle of Mathematical Induction, assume all results for $m-1$ letters corresponding to those which we propose to establish for m letters, viz.,

$$\begin{vmatrix} b^{m-2}, & c^{m-2}, & \ldots & l^{m-2} \\ b^{m-3}, & c^{m-3}, & \ldots & l^{m-3} \\ \cdot & \cdot & \cdot & \cdot \\ b^2, & c^2, & \ldots & l^2 \\ b, & c, & \ldots & l \\ 1, & 1, & \ldots & 1 \end{vmatrix} = (bcd\ldots l). \qquad (1')$$

$$\begin{vmatrix} b^{p}, & c^{p}, & \ldots & l^{p} \\ b^{m-3}, & c^{m-3}, & \ldots & l^{m-3} \\ \cdot & \cdot & \cdot & \cdot \\ b^2, & c^2, & \ldots & l^2 \\ b, & c, & \ldots & l \\ 1, & 1, & \ldots & 1 \end{vmatrix} = (bcd\ldots l)\,h'_{p-m+2}. \qquad (2')$$

$$\begin{vmatrix} b^{p}, & c^{p}, & \ldots & l^{p} \\ b^{q}, & c^{q}, & \ldots & l^{q} \\ b^{m-4}, & c^{m-4}, & \ldots & l^{m-4} \\ \cdot & \cdot & \cdot & \cdot \\ b, & c, & \ldots & l \\ 1, & 1, & \ldots & 1 \end{vmatrix} = (bcd\ldots l)\begin{vmatrix} q-m+3, & q-m+2 \\ p-m+3, & p-m+2 \end{vmatrix}'. \qquad (3')$$

$$\begin{vmatrix} b^p, & \\ b^q, & \\ b^r, & \&c. \\ b^{m-4}, & \\ \vdots & \\ b, & \\ 1, & \end{vmatrix} = (bcd \ldots l) \begin{vmatrix} r-m+4, & r-m+3, & r-m+2 \\ q-m+4, & q-m+3, & q-m+2 \\ p-m+4, & p-m+3, & p-m+2 \end{vmatrix}'. \qquad (4')$$

And, generally, for $m-2$ general indices $p, q, r, \ldots y, z$.

$$\begin{vmatrix} b^p, & \\ b^q, & \\ b^r, & \&c. \\ \cdot & \\ \cdot & \\ b^z, & \\ 1, & \end{vmatrix} = (bcd \ldots l) \begin{vmatrix} z-1, & z-2, & \ldots\ z-m+2 \\ y-1, & y-2, & \ldots\ y-m+2 \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ q-1, & q-2, & \ldots\ q-m+2 \\ p-1, & p-2, & \ldots\ p-m+2 \end{vmatrix}' \qquad (m-1)',$$

where h_n' denotes the sum of the homogeneous products of $b, c, d \ldots l$ and their powers of n dimensions; and where in the determinants on the right-hand side the elements are in reality h's, but for convenience, and in order to better observe the law of formation, the suffixes only are written. These $m-1$ results are necessary and sufficient to obtain the m corresponding results in the case of m letters.

Expanding the terms in the left-hand side of (A), and equating the absolute terms in both sides of the equation, we shall get by (1′),

$$\begin{vmatrix} a^{m-1}, & b^{m-1}, & \ldots\ l^{m-1} \\ a^{m-2}, & b^{m-2}, & \ldots\ l^{m-2} \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ a^2, & b^2, & \ldots\ l^2 \\ a, & b, & \ldots\ l \\ 1, & 1, & \ldots\ 1 \end{vmatrix} = (abc \ldots l). \qquad (1)$$

Also equating coefficients of the several remaining like powers of x in both sides of (A), we shall get a series of similar results, the general one of which is, by (1′),

$$\begin{vmatrix} a^n, & b^n, & \dots l^n \\ a^{m-2}, & b^{m-2}, & \dots l^{m-2} \\ \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot \\ a^2, & b^2, & \dots l^2 \\ a, & b, & \dots l \\ 1, & 1, & \dots 1 \end{vmatrix} = (abc \dots l)\, h_{n-m+1}. \qquad (2)$$

4. We now propose to obtain corresponding results in the cases of 2, 3, 4, ... and $m-1$ general indices.

In the case of two general indices, it may be shown by (2′) that

$$\begin{vmatrix} a^n, & \\ a^p, & \\ a^{m-2}, & \&c. \\ \vdots & \\ a, & \\ 1, & \end{vmatrix} = a^n (bcd \dots l)\, h'_{p-m+2} - \&c.$$

Now it may readily be shown that

$$h_n = ah_{n-1} + h_n', \qquad (B)$$

h_n' referring to $b, c, d, \dots l$.

Hence, the right-hand member of the above equation becomes by (1′),

$$\begin{vmatrix} a^n, & \\ a^{m-2}, & \\ \vdots & \&c. \\ a, & \\ 1, & \end{vmatrix} h_{p-m+2} - \begin{vmatrix} a^{n+1}, & \\ a^{m-2}, & \\ \vdots & \&c. \\ a, & \\ 1, & \end{vmatrix} h_{p-m+1},$$

which, by (2),

$$= (abc \dots l) \begin{vmatrix} p-m+2, & p-m+1 \\ n-m+2, & n-m+1 \end{vmatrix}. \qquad (3)$$

Again, in the case of three general indices, it is shown by (3′) that

$$\begin{vmatrix} a^n, & \\ a^p, & \\ a^q, & \&c. \\ a^{m-4}, & \\ \vdots & \\ a, & \\ 1, & \end{vmatrix} = a^n\,(bcd\ldots l)\begin{vmatrix} q-m+3, & q-m+2 \\ p-m+3, & p-m+2 \end{vmatrix}' - \&c.$$

Changing those terms involving q from h' to h by the relation (B), the right-hand side becomes, by (2′),

$$\begin{vmatrix} a^n, & \\ a^p, & \\ a^{m-3}, & \&c. \\ \vdots & \\ a, & \\ 1, & \end{vmatrix} h_{q-m+3} - \left\{\begin{vmatrix} a^{n+1}, & \\ a^p, & \\ a^{m-3}, & \&c. \\ \vdots & \\ a, & \\ 1, & \end{vmatrix} + \begin{vmatrix} a^n, & \\ a^{p+1}, & \\ a^{m-3}, & \&c. \\ \vdots & \\ a, & \\ 1, & \end{vmatrix}\right\} h_{q-m+2} + \begin{vmatrix} a^{n+1}, & \\ a^{p+1}, & \\ a^{m-3}, & \&c. \\ \vdots & \\ a, & \\ 1, & \end{vmatrix} h_{q-m+1};$$

and this, by (3), and an extension of it, is equal to ($abc\ldots l$) multiplied by

$$\begin{vmatrix} p-m+2, & p-m+1 \\ n-m+2, & n-m+1 \end{vmatrix} h_{q-m+3} - \begin{vmatrix} p-m+3, & p-m+1 \\ n-m+3, & n-m+1 \end{vmatrix} h_{q-m+2}$$

$$+ \begin{vmatrix} p-m+3, & p-m+2 \\ n-m+3, & n-m+2 \end{vmatrix} h_{q-m+1}$$

that is, by

$$\begin{vmatrix} q-m+3, & q-m+2, & q-m+1 \\ p-m+3, & p-m+2, & p-m+1 \\ n-m+3, & n-m+2, & n-m+1 \end{vmatrix}. \tag{4}$$

And in like manner it is deduced, in the case of four general indices, that

$$\left|\begin{array}{ll} a^n, & \\ a^p, & \\ a^q, & \\ a^r, & \&c. \\ a^{m-5} & \\ \vdots & \\ a, & \\ 1, & \end{array}\right| = (abc\ldots l)\left|\begin{array}{llll} r-m+4, & r-m+3, & r-m+2, & r-m+1 \\ q-m+4, & & & \\ p-m+4, & & X & \\ n-m+4, & & & \end{array}\right|, \quad (5)$$

where X denotes the determinant (4) in the preceding case.

The law of formation of the results in the cases of five, six, and any number of general indices, is now obvious; and in order to establish the most general case of $m-1$ general indices $n, p, q, \ldots x, y, z$, we assume, by the principle of Induction, the case of $m-2$ general indices $n, p, q, \ldots x, y$, viz.:—

$$\left|\begin{array}{ll} a^n, & \\ a^p, & \\ a^q, & \\ \vdots & \&c. \\ a^y, & \\ a, & \\ 1, & \end{array}\right| = (abc\ldots l)\left|\begin{array}{llll} y-2, & y-3, & \ldots & y-m+1 \\ x-2, & x-3, & \ldots & x-m+1 \\ \vdots & \vdots & & \vdots \\ p-2, & p-3, & \ldots & p-m+1 \\ n-2, & n-3, & \ldots & n-m+1 \end{array}\right|, \; .. \quad (m-1)$$

the right-hand side of which we will, for convenience, denote by

$$(abc\ldots l)(234\ldots m-1).$$

By the equation $(m-1)'$ it is readily shown that

$$\left|\begin{array}{ll} a^n, & \\ a^p, & \\ a^q, & \\ \vdots & \&c. \\ a^z, & \\ 1, & \end{array}\right| = a^n(bcd\ldots l)\left|\begin{array}{llll} z-1, & z-2, & \ldots & z-m+2 \\ y-1, & y-2, & \ldots & y-m+2 \\ \vdots & \vdots & & \vdots \\ q-1, & q-2, & \ldots & q-m+2 \\ p-1, & p-2, & \ldots & p-m+2 \end{array}\right|' - \&c.,$$

the (′) referring to the homogeneous products of $b, c, d, \ldots l$.

Changing from h' to h in the terms involving s only, by the relation (B), and for convenience denoting the determinant

$$\begin{vmatrix} y-2, & y-3, & \ldots & y-m+2 \\ x-2, & x-3, & \ldots & x-m+2 \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ p-2, & p-3, & \ldots & p-m+2 \end{vmatrix}' \text{ by } (234\ldots m-2)',$$

the right-hand side of the above equation becomes

$$\begin{aligned} &\{a^n(bc\ldots l)(234\ldots m-2)' - \&c.\}\, h_{s-1} \\ &- \{a^{n+1}(bc\ldots l)(234\ldots m-2)' - \&c. + a^n(bc\ldots l)(134\ldots m-2)' - \&c.\}\, h_{s-2} \\ &+ \{a^{n+1}(bc\ldots l)(134\ldots m-2)' - \&c. + a^n(bc\ldots l)(124\ldots m-2)' - \&c.\}\, h_{s-3} \\ &- \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ &+ (-1)^{m-3}\{a^{n+1}(bc\ldots l)(123\ldots m-4,\ m-2)' - \&c. \\ &\qquad\qquad\qquad + a^n(bc\ldots l)(123\ldots m-3)' - \&c.\}\, h_{s-m+2} \\ &+ (-1)^{m-2}\{a^{n+1}(bc\ldots l)(123\ldots m-3)' - \&c.\}\, h_{s-m+1}, \end{aligned}$$

where we observe, in respect of the coefficients of the various h's, that the first and last consist each of one series of terms, while of the others, each consists of two series of terms, and where the law of their formation is obvious on inspection.

But by the case of $m-1$ letters and $m-3$ general indices, we have

$$\begin{vmatrix} b^p, & \\ b^q, & \\ \vdots & \&c. \\ b^v, & \\ b, & \\ 1, & \end{vmatrix} = (bcd\ldots l)(234\ldots m-2)',$$

and by this, and its *Extensions*, the foregoing expression is equal to

$$\begin{vmatrix} a^n, & \\ a^p, & \\ a^q, & \\ \vdots & \&c. \\ a^v, & \\ a, & \\ 1, & \end{vmatrix} h_{s-1} - \Sigma \begin{vmatrix} a^{n+1}, & \\ a^p, & \\ a^q, & \\ \vdots & \&c. \\ a^v, & \\ a, & \\ 1, & \end{vmatrix} h_{s-2} + \Sigma \begin{vmatrix} a^{n+1}, & \\ a^{p+1}, & \\ a^q, & \\ \vdots & \&c. \\ a^v, & \\ a, & \\ 1, & \end{vmatrix} h_{s-3} - \Sigma \begin{vmatrix} a^{n+1}. & \\ a^{p+1}, & \\ a^{q+1}, & \\ a^r, & \&c. \\ \vdots & \\ a^v, & \\ a, & \\ 1, & \end{vmatrix} h_{s-4}$$

$$+\ldots+(-1)^{m-3}.\,\Sigma\begin{vmatrix} a^{n+1}, \\ a^{p+1}, \\ \vdots \\ a^{x+1}, \&\text{c.} \\ a^{v}, \\ a, \\ 1, \end{vmatrix} h_{s-m+2}+(-1)^{m-2}\begin{vmatrix} a^{m+1}, \\ a^{p+1}. \\ a^{q+1}, \\ \vdots \quad \&\text{c.} \\ a^{y+1}, \\ a, \\ 1, \end{vmatrix} h_{s-m+1},$$

which by the equation $(m-1)$ and its *Extensions* is equal to $(abc\ldots l)$ multiplied by

$$(234\ldots m-1)\,h_{s-1}-(134\ \ldots m-1)\,h_{s-2}$$

$$+(124\ldots m-1)\,h_{s-3}-(1235\ldots m-1)\,h_{s-4}$$

$$+\quad .\quad .\quad .\quad .\quad .\quad .\quad .\quad .\quad .$$

$$+(-1)^{m-3}.\,(123\ldots m-3,\ m-1)\,h_{s-m+2}+(-1)^{m-2}.\,(123\ldots m-2)\,h_{s-m+1}\,;$$

and thus we have

$$\begin{vmatrix} a^{n}, & b^{n}, & \ldots & l^{n} \\ a^{p}, & b^{p}, & \ldots & l^{p} \\ a^{q}, & b^{q}, & \ldots & l^{q} \\ \vdots & \vdots & & \vdots \\ a^{s}, & b^{s}, & \ldots & l^{s} \\ 1, & 1, & \ldots & 1 \end{vmatrix} = (abc\ldots l)\begin{vmatrix} x-1, & x-2, & x-3, & \ldots x-m+1 \\ y-1, & y-2, & y-3, & \ldots y-m+1 \\ \vdots & \vdots & \vdots & \vdots \\ q-1, & q-2, & q-3, & \ldots q-m+1 \\ p-1, & p-2, & p-3, & \ldots p-m+1 \\ n-1, & n-2, & n-3, & \ldots n-m+1 \end{vmatrix}, \quad (m)$$

and hence the proposition is completely established.

5. In the foregoing investigation reference has been made to *Extensions* of various results, which it is necessary to state and prove (not only because they are necessary to establish the main proposition, but also on account of their own individual importance and interest). Strictly speaking, these extensions should be incorporated with the foregoing work; but to avoid confusion, and to allow all *similar* results to follow one another without any digression, it is desirable that the extensions should be treated separately, which we now propose to do.

Denoting, for convenience, the determinant involving the general indices $n, p, q, \ldots x$ by the symbol $[n, p, q, \ldots x]$, we have, by (3),

$$[n, p] = (abc\ldots l)\begin{vmatrix} p-m+2, & p-m+1 \\ n-m+2, & n-m+1 \end{vmatrix} = D(21), \text{ suppose.}$$

Then it is readily shown that

$$[n+1,\ p] + [n,\ p+1] = D(31), \qquad \text{(i)}$$

which is the only Extension in the case of two general indices.

Again, by (4), we have

$$[n, p, q] = D(321),$$

from which it is deduced by (i), that

$$[n+1,\ p, q] + [n,\ p+1,\ q] + [n, p,\ q+1] = D(421), \qquad \text{(ii)}$$

and

$$[n+1,\ p+1,\ q] + [n+1,\ p,\ q+1] + [n,\ p+1,\ q+1] = D(431), \qquad \text{(iii)}$$

which two results are the Extensions in the case of three general indices.

And again, using four general indices, we have, by (5),

$$[n, p, q, r] = D(4321),$$

from which it is deduced by (ii) that

$$\Sigma[n+1,\ p, q, r],$$

having four times in each of which there is one index of the form $\lambda + 1$, is equal to $D(5321) + D(4421)$, the latter of which, being zero, gives

$$\Sigma(n+1,\ p, q, r] = D(5321). \qquad \text{(iv)}$$

Also, it is in like manner shown by the application of (iii) that

$$\Sigma[n+1,\ p+1,\ q+1,\ r],$$

having four terms, in each of which there are three indices of the form $\lambda + 1$, is equal to $D(5431) + D(2542)$; and thus

$$\Sigma[n+1,\ p+1,\ q+1] = D(5431). \qquad \text{(v)}$$

And lastly, to find the corresponding value of $\Sigma[n+1, p+1, q, r]$, which consists of six terms, each of which has two indices of the form $\lambda + 1$, it is shown by considering separately the terms involving a^r from those having a^{r+1}, that by (ii) and (iii) we get

$$D(5421) + D(2532);$$

and thus

$$\Sigma[n+1,\ p+1,\ q,\ r] = D(5421). \qquad \text{(vi)}$$

These results, (iv), (v), and (vi), are the Extensions in the case of four general indices.

Generally, to establish the *Extensions* in the case of $m-2$ general indices (which are necessary to prove the final case of $m-1$ general indices in the main proposition), we assume the *Extensions* in the case of $m-3$ general indices.

We have

$$\begin{vmatrix} a^n, & \\ a^p, & \\ a^q, & \\ \vdots & \text{\&c.,} \\ a^x, & \\ a^2, & \\ a, & \\ 1, & \end{vmatrix} = D \begin{vmatrix} x-3, & x-4, & \dots & x-m+1 \\ \cdot & \cdot & & \cdot \\ \cdot & \cdot & & \cdot \\ q-3, & q-4, & \dots & q-m+1 \\ p-3, & p-4, & \dots & p-m+1 \\ n-3, & n-4, & \dots & n-m+1 \end{vmatrix},$$

which, according to the previous notation, we write

$$[n, p, q, \dots x] = D(345 \dots m-1);$$

the *Extensions* of which are $m-4$ in number, and are as follows:—

$$\Sigma[n+1, p, q, \dots x] \qquad = D(245 \dots m-1), \qquad (\alpha')$$

$$\Sigma[n+1, p+1, q, \dots x] \qquad = D(235 \dots m-1), \qquad (\beta')$$

$$\Sigma[n+1, p+1, q+1, r, \dots x] = D(2346 \dots m-1), \qquad (\gamma'$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot$$

$$\Sigma[n+1, p+1, \dots u+1, x] \quad = D(234 \dots m-3, m-1), \quad (\mu-4)'$$

the Σ's consisting respectively of $m-3$, ${}_{m-3}C_2$, ${}_{m-3}C_3$, ..., and ${}_{m-3}C_{m-4}$ terms, where ${}_mC_r$ denotes the number of combinations of m things taken r together; and the law of formation of the coefficients of D being obvious on inspection.

To deduce the Extensions for $m-2$ general indices $n, p, q, \dots x, y$, we have, by equation $(m-1)$,

$$[n, p, q, \dots y] = D(234 \dots m-1).$$

Now

$$\Sigma[n+1, p, q, \dots y] = DS, \text{ suppose,}$$

where S denotes the sum of the $m-2$ corresponding determinants; and it is easily shown that $S = (134 \dots m-1) + A$, where by (α') it is shown that $A = (2245 \dots m-1)$, that is, 0. Thus we have

$$\Sigma[n+1, p, q, \dots y] = D(134 \dots m-1). \qquad (a)$$

Again, to find the value of

$$\Sigma\left[n+1,\ p+1,\ q,\ \ldots\ y\right],$$

having ${}_{m-2}C_2$ terms, in each of which there are two indices of the form $\lambda+1$,—it will be convenient to divide the series into two parts, considering separately those terms in which the index $y+1$ occurs from the rest.

There are $\mu-3$ terms having this index, the sum of which is shown by (α') to be equal to

$$D(124\ \ldots\ m-1).$$

Also, the sum of the remaining ${}_{m-3}C_2$ terms in which the index y occurs, is shown by (β') to be equal to $D(2235\ \ldots\ m-1)$, that is, 0; and thus we have

$$\Sigma\left[n+1,\ p+1,\ q,\ \ldots\ y\right] = D(124\ \ldots\ m-1). \qquad (\beta)$$

In like manner, to find the value of

$$\Sigma\left[n+1,\ p+1,\ q+1,\ r,\ \ldots\ y\right],$$

having ${}_{m-2}C_3$ terms, in each of which there are three indices of the form $\lambda+1$—it is shown by (β') that the sum of the ${}_{m-3}C_2$ terms in which the index $y+1$ occurs is equal to

$$D(1235\ \ldots\ m-1);$$

while by (γ') the sum of the remaining ${}_{m-3}C_3$ terms involving the index y is equal to $D(22346\ \ldots\ m-1)$, that is, 0; and thus we have

$$\Sigma\left[n+1,\ p+1,\ q+1,\ r,\ \ldots\ y\right] = D(1235\ \ldots\ m-1). \qquad (\gamma)$$

Similarly, when each term in Σ has four indices of the form $\lambda+1$, it is deduced that

$$\Sigma_4 = D(12346\ \ldots\ m-1), \qquad (\delta)$$

and generally, if indices of the form $\lambda+1$ occur μ at a time in each term of Σ, it is shown that

$$\Sigma_\mu = D(123\ \ldots\ \mu,\ \mu+2,\ \ldots\ \mu-1). \qquad (\mu)$$

While lastly, if there are $m-3$ indices of this form in each term of Σ, we shall get

$$\Sigma\left[n+1,\ p+1,\ q+1,\ \ldots\ x+1,\ y\right] = D(123\ \ldots\ m-3,\ m-1), \qquad \ldots (m-3)$$

the number of terms in Σ being $m-2$, which completes the Extensions generally, the law of formation of the successive results being obvious on inspection.

6. The foregoing Extensions are necessary to establish the main proposition of the Paper. The following results, deducible from them, are however interesting, and may be worthy of notice.

Using m letters, $a, b, c \dots l$, we have, in the case of two general indices n and p,

$$[n, p] = D(m-2,\ m-1),$$

the complete sum arising out of which, namely,

$$[n, p] - [n+1,\ p] - [n,\ p+1] + [n+1,\ p+1]$$

is, by (i), equal to

$$D(m-2,\ m-1) - D(m-3,\ m-1) + D(m-3,\ m-2),$$

that is,

$$D\begin{vmatrix} 1 & 1 & 1 \\ p-m+3, & p-m+2, & p-m+1 \\ n-m+3, & n-m+2, & n-m+1 \end{vmatrix}, \qquad \text{(I.)}$$

the number of terms being 2^2.

Again, in the case of three general indices, n, p, q, we have

$$[n,\ p,\ q] = D(321),$$

the complete sum, involving the extensions, arising out of which, namely,

$$[n, p, q] - \Sigma[n+1,\ p,\ q] + \Sigma(n+1,\ p+1,\ q) - (n+1,\ p+1,\ q+1]$$

is, by (ii) and (iii), equal to

$$D(321) - D(421) + D(431) - D(432),$$

that is,

$$D\begin{vmatrix} 1 & 1 & 1 & 1 \\ q-m+4, & q-m+3, & q-m+2, & q-m+1 \\ p-m+4, & p-m+3, & p-m+2, & p-m+1 \\ n-m+4, & n-m+3, & n-m+2, & n-m+1 \end{vmatrix}, \qquad \text{(II.)}$$

the total number of terms being $1+3+3+1$, *i.e.* 2^3.

Likewise, the complete sum, involving Extensions, arising out of

$$[n, p, q, r] = D(4321),$$

namely,

$$[n, p, q, r] - \Sigma[n+1, p, q, r] + \Sigma[n+1, p+1, q, r] - \Sigma[n+1, p+1, q+1, r]$$
$$+ [n+1,\ p+1,\ q+1,\ r+1]$$
$$= D(4321) - D(5321) + D(5421) - D(5431) + D(5432),$$

that is,

$$D\left|\begin{array}{ll} 1 & 1\;1\;1\;1 \\ r-m+5, & \\ q-m+5, & (4321) \\ p-m+5, & \\ n-m+5, & \end{array}\right|, \qquad \text{(III.)}$$

the total number of terms in the left-hand side being $1+4+6+4+1$, *i.e.* 2^4; and where we see that to obtain this result we simply border (4321), the equivalent of $[n, p, q, r]$, as indicated by (III.).

Generally, in the case of $m-2$ general indices, we have

$$[n, p, q, \ldots y] = D(234 \ldots m-1);$$

and the complete sum, involving Extensions, arising out of this, namely,

$$[n, p, q, \ldots y] - \Sigma\,[n+1, p, q, \ldots y) + \Sigma\,[n+1, p+1, q, \ldots y]$$
$$- \ldots + (-1)^{m-2}\,[n+1, p+1, q+1, \ldots y+1]$$
$$= D(234 \ldots m-1) - D(134 \ldots m-1) + D(124 \ldots m-1)$$
$$- \ldots + (-1)^{m-2}\,D(123 \ldots m-2),$$

that is,

$$D\left|\begin{array}{ll} 1, & 1 \;\ldots\; 1 \\ y-1, & \\ x-1, & \\ \vdots & (234 \ldots m-1) \\ q-1, & \\ p-1, & \\ n-1, & \end{array}\right|, \qquad (M-3)$$

in which we see that to obtain this result we simply border $(234 \ldots m-1)$, the equivalent of $[n, p, q, \ldots y]$, as shown by $(M-3)$; and the total number of terms in the left-hand series is

$$1 + {}_{m-2}C_1 + {}_{m-2}C_2 + \ldots + {}_{m-2}C_{m-3} + 1,$$

that is, the total number of combinations of $m-2$ things $+ 1$, *i.e.* 2^{m-2}

Professor Malet, F.R.S., who speaks of the general result (m) in the main proposition as a very pretty one, has suggested the following direct *proof* of it, and has kindly given me permission to state it here:—

Taking the m letters $a, b, c, \ldots l$, the determinant

$$\begin{vmatrix} a^{m-1}, & b^{m-1}, & \ldots & l^{m-1} \\ a^{m-2}, & b^{m-2}, & \ldots & l^{m-2} \\ \vdots & \vdots & & \vdots \\ a, & b, & \ldots & l \\ 1, & 1, & \ldots & 1 \end{vmatrix} = (abc \ldots l) = D, \text{ say,}$$

where $(abc \ldots l)$ stands for the product of the differences in pairs of the m letters $a, b, c, \ldots l$.

Now let

$$\alpha = \frac{1}{(a-b)(a-c)\ldots(a-l)}, \quad \beta = \frac{1}{(b-a)(b-c)\ldots(b-l)}, \ldots$$

$$\lambda = \frac{1}{(l-a)(l-b)\ldots(l-k)},$$

so that $\qquad \alpha\beta \ldots \lambda = \dfrac{1}{D^2}$; then

$$\alpha a^p + \beta b^p + \ldots + \lambda l^p = 0,\ 1, \text{ or } h_{p-m+1},$$

according as p is $<\ =$ or $> m-1$, where h_n is the sum, including powers, of the homogeneous products of n dimensions of the letters.

Now let

$$\Delta = \begin{vmatrix} \alpha a^{m-1}, & \beta b^{m-1}, & \ldots & \lambda l^{m-1} \\ \alpha a^{m-2}, & \beta b^{m-2}, & \ldots & \lambda l^{m-2} \\ \vdots & \vdots & & \vdots \\ \alpha a, & \beta b, & \ldots & \lambda l \\ \alpha, & \beta, & \ldots & \lambda \end{vmatrix} = \frac{1}{D};$$

then if we call

$$\begin{vmatrix} a^n, & b^n, & \ldots & l^n \\ a^p, & b^p, & \ldots & l^p \\ a^q, & b^q, & \ldots & l^q \\ \vdots & \vdots & & \vdots \\ a^s, & b^s, & \ldots & l^s \\ 1, & 1, & \ldots & 1 \end{vmatrix} = \nabla,$$

by the rule for the multiplication of determinants we get at once

$$\Delta\nabla = \frac{\nabla}{D} = \begin{vmatrix} h_n, & h_{n-1}, & \dots & h_{n-m+1} \\ h_p, & h_{p-1}, & \dots & h_{p-m+1} \\ h_q, & h_{q-1}, & \dots & h_{q-m+1} \\ \vdots & \vdots & & \vdots \\ h_s, & h_{s-1}, & \dots & h_{s-m+1} \\ 1 & 0 & \dots & 0 \end{vmatrix},$$

that is,

$$\nabla = D \begin{vmatrix} h_{n-1}, & h_{n-2}, & \dots & h_{n-m+1} \\ h_{p-1}, & h_{p-2}, & \dots & h_{p-m+1} \\ h_{q-1}, & h_{q-2}, & \dots & h_{q-m+1} \\ \vdots & \vdots & & \vdots \\ h_{s-1}, & h_{s-2}, & \dots & h_{s-m+1} \end{vmatrix}.$$

XLI.—ON THE POSSIBILITY OF DETERMINING THE DISTANCE OF A DOUBLE STAR BY MEASURES OF THE RELATIVE VELOCITIES OF THE COMPONENTS IN THE LINE OF SIGHT. By ARTHUR A. RAMBAUT.

[Read, May 24, 1886.]

SAVARY, in his memoir on double stars, in view of the difference of the times that light takes to reach us from the two components of a double star, on account of their unequal distances from our solar system, concludes the existence of an inequality in their relative apparent motion, and indicates the possibility of deducing thence an inferior limit of their parallax. "In fact," he says, "if light required, to traverse the orbit of a double star, a time equal to that in which the star moves through a measurable angle, we should see this star as much behind its real position, relatively to the star considered as the centre of motion, as it was in a part of its orbit more distant from us. . ."

M. Arago developed this idea of Savary's, and drew the attention of astronomers to the question in *l'Annuaire du Bureau des Longitudes;* and some years later M. Struve, in his great work on double stars, examined to what extent this inequality, which he termed the "equation of light," could become sensible.

There had been up to this time no mathematical theory of the equation of light, and M. Houzeau, who had met with considerable anomalies in the measures of 70 *p* Ophiuchi, attempted to attribute them to relative aberration, arising from the relative motion of the stars. This supposition of M. Houzeau's was attacked by Sir John Herschel, who denied positively that the motion could have any influence.

The question was in this condition when M. Villearceau took it up and examined it in his elaborate memoir on the *Theorie Analytique des Inégalités de Lumiere des Etoiles Doubles*, published in the *Connaissances des Temps* for 1878.

In summing up the results of his investigation he finds four different effects of aberration. Of the first three he says: "All the effects of the aberration, indicated up to this, are represented by the elliptic motion, whose elements, with the exception of two, the major axis and the eccentricity, are effected with inequalities, on account of the distance of the Sun, the velocity with which this distance varies, and the angular motion of the components. The inequalities produced in the elements offer an interest merely speculative." Of the fourth, which depends on the ratio of the masses, he says: "The introduction of the inequality depending on the ratio of the masses . . . would permit us to obtain an unknown containing this ratio associated with the parallax, if this inequality could acquire a sensible value. The parallax could be deduced from this if the ratio of the masses was known. But

since this ratio is entirely unknown, we see that *the inequality of light cannot serve to fix even an inferior limit to the parallax.*"

I have briefly summarised the results of investigations on this subject as far as I know of them, because they are closely allied to the subject of this paper, and because if an effect so small, even if it could be detected, and so inseparably mixed up with the determination of the elements themselves, that it is impossible to disconnect them; if such an effect has been looked to at one time by astronomers to afford a clue to the parallax, there is some excuse for drawing attention to another inequality of light which is undoubtedly extremely small; but if it fails to give us the value of the parallax, the failure is due, not to any inherent impossibility in the problem itself, but to the inability of our instrumental means to measure its effect.

In the case of a double star whose orbit has been determined, if we knew the distance, we could calculate the actual linear velocity at any moment in miles per second: and inversely, if we knew this velocity, we should be able to deduce thence its distance. We are able by means of the spectroscope to determine the resolved parts of the velocities of each of the components in the line of sight, the difference of which is the resolved part of the relative velocity in the same direction, which will of course enable us to find the whole velocity, and thence to obtain the distance. I proceed to find the relation connecting the parallax and the velocity:—

If v is the velocity in the orbit at the time under consideration, and if V is the velocity in the line of sight, then V is the resolved part of v parallel to the latter line.

Now if, adopting the usual notation, λ denote the angle between the line of nodes and the line of apsides of the orbit, and if γ denote the inclination of the orbit to the tangent plane to the sphere of the heavens at the point occupied by the primary, and if ϕ denote the angle between the tangent to the orbit and the line of apsides, then $\phi - \lambda$ is the angle between the tangent and the line of nodes. Resolving the velocity parallel to and at right angles to the line of nodes, we get $v\cos(\phi-\lambda)$, $v\sin(\phi-\lambda)$. The former of these being at right angles to the line of sight has no effect on the velocity parallel to that line, while the latter makes with that line an angle equal to $\frac{\varpi}{2} - \gamma$. We have, therefore, the whole velocity parallel to the line of sight $= v\sin(\phi-\lambda)\sin\gamma$.

Now $v = \frac{h}{p}$, where h is twice the area described in a unit of time, and p is the perpendicular on the tangent from the focus occupied by the primary. Also $h = \frac{2\varpi a_1 b_1}{P}$, a_1, b_1 being the semiaxes of the orbit, and P the period in years, and $p = \frac{b_1 r}{b'}$, whence $v = \frac{2\varpi a_1 b'}{Pr}$. But

$b' = \dfrac{a_1\sqrt{1-\epsilon^2}}{\sqrt{1-\epsilon^2\cos^2\phi}}$; we have, therefore, $v = \dfrac{2\varpi a_1^2\sqrt{1-\epsilon^2}}{Pr\sqrt{1-\epsilon^2\cos^2\phi}}$. And if a is the semi-major-axis, measured as usual in seconds of arc, and if Π denotes the parallax, and R the radius of the Earth's orbit, $a_1 = \dfrac{Ra}{\Pi}$; whence we have (r being also expressed in seconds of arc)

$$\Pi V = \frac{2\varpi a^2\sqrt{1-\epsilon^2}\,.\,R\,.\,\sin(\phi-\lambda)\sin\gamma}{Pr\sqrt{1-\epsilon^2\cos^2\phi}}.$$

In this formula the unit of time is a year. So that if V is expressed in miles per second, we must divide the right-hand side by $365 \times 24 \times 60 \times 60 = s$. Then $\dfrac{2\varpi R}{s} = l$ is the mean distance traversed by the Earth per second, and we have finally

$$\Pi V = \frac{la^2\sqrt{1-\epsilon^2}\sin(\phi-\lambda)\sin\gamma}{Pr\sqrt{1-\epsilon^2\cos^2\phi}}.$$

To find the angle ϕ, we have $\tan\phi = -\dfrac{b^2x'}{a^2y'}$, x' and y' being the co-ordinates of the position in the orbit referred to the centre and axes of the ellipse, or $\tan\phi = -\dfrac{b^2}{a^2}\cdot\dfrac{x+c}{y}$, x and y being the co-ordinates of the same point referred to the major axis and the *latus rectum*. Therefore

$$\tan\phi = -(1-\epsilon^2)\frac{r\cos\theta + a\epsilon}{r\sin\theta}.$$

The equations necessary to find the parallax are, therefore, the ordinary equations of elliptic motion—

$$(1) \qquad u - \epsilon\sin u = nt,$$

$$(2) \qquad \tan\frac{\theta}{2} = \sqrt{\frac{1+\epsilon}{1-\epsilon}}\tan\frac{u}{2},$$

$$(3) \qquad r = a(1-\epsilon\cos u);$$

in which a, ϵ, n, t denote respectively the semi-axis-major, the eccentricity, the mean angular motion, and the time from periastron; while r, θ, and u denote the radius vector, the true anomaly, and the eccentric anomaly; and

$$(4) \qquad \tan\phi = -(1-\epsilon^2)\frac{r\cos\theta + a\epsilon}{r\sin\theta};$$

$$(5) \qquad \Pi V = \frac{la^2\sqrt{1-\epsilon^2}\,.\sin(\phi-\lambda)\sin\gamma}{Pr\sqrt{1-\epsilon^2\cos^2\phi}} = k,$$

in which ϕ denotes the angle between the tangent and the major-axis;
λ " " " the line of nodes " ";
γ " " " the plane of orbit and tangent plane to sphere;
P " period in years,
Π " parallax in secs. of arc,
V " the velocity in miles per second in the line of sight, } of the star;
and l " mean motion of the Earth in miles.

The equation (5) gives us, then, a relation between Π and V, depending only on the period and the angular elements of the orbit. If one is measured, we can at once determine the other. If the quantity k be greater than unity at any time, we know one of two things—either that the parallax is not less than one-tenth of a second of arc, or that the velocity in the line of sight is not less than ten miles a second. If, then, on turning the spectroscope on the star we find that the lines in both spectra are absolutely coincident in position, we know that the parallax is not less than one-tenth of a second, and will repay all the care that may be bestowed on its determination. On the other hand, if there is any displacement visible, the measurement of its amount will give us the value of V, and consequently of Π. Thus all double stars, for which k is at any time greater than unity, may be said to be within measurable distance either by the spectroscopic or the trigonometrical method.

On the other hand, if k is less than unity it does not follow that the distance defies measurement, for a sensible value of Π may be counterbalanced by the smallness of the linear dimensions of the orbit, or the length of the period, giving a small value for V; whereas if k is less than unity, and V is found of any considerable magnitude, it informs us with a certainty, which the mere failure to measure its parallax trigonometrically could never reach, that the star is at an inconceivable distance from the solar system.

All this is on the supposition that a parallax not greater than $0''\cdot1$ could be measured by the best modern methods, and that the spectroscope could detect a velocity as small as ten miles per second.

I have, purposely, taken a very small limit for the parallax—for this reason, that if it is ascertained by other means that Π is not less than one-tenth of a second, an observer may perhaps take more extraordinary precautions, and may extend his observations over a longer period than if the nature of the ultimate result was doubtful, since he knows he must, if his observations are correct, get a sensible value for the parallax. Nor is ten miles per second, I think, too small a limit

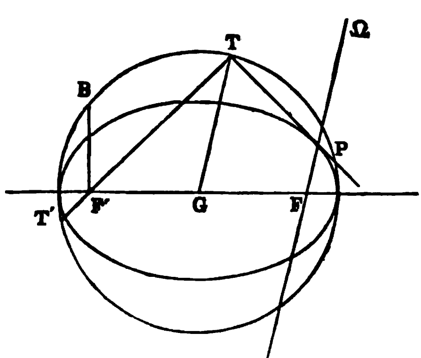
for the value of V. In the Greenwich results, velocities as small as this are sometimes recorded, which shows that they can be detected by the eye; and though, in comparing the spectrum of a star with that of some terrestrial substance in a vacuum tube, this small displacement may not be worthy of much confidence, as it might be altogether due to some want of adjustment of the apparatus: yet in the case before us, where the two spectra are presented in the telescope under exactly the same conditions, any displacement at all visible must be due to some relative velocity of the components. The photographic process, also, may detect small displacements to which the eye is insensible. Professor Pickering, speaking of the Draper photographs of stellar spectra, says: "The present results encourage the expectation that the movements of stars in the line of sight may be better determined by the photographic method than by direct observation." But, even if the limits I have chosen should be thought too small, the only change would be to increase what may be termed the *critical value of k*.

Now it will be interesting, I think, to find for what stars k is greater than unity; and although in deducing a value of the parallax from the observed value of V, it will be necessary to compute it from the complete formula; yet in merely searching for stars, for which k may at any time exceed this value, a rougher method will be sufficiently precise. There is a very simple graphical method which will give us what we require with considerable accuracy. Since $p = \frac{br}{b'}$, equation (5), may evidently be written

$$\Pi V = \frac{lab}{P.p} \sin(\phi - \lambda) \sin\gamma;$$

or, since $pp' = b^2$, p' being the perpendicular from the other focus, it may also be written

$$\Pi V = \frac{lap' \sin(\phi - \lambda) \sin\gamma}{P.b}.$$



Now $p' \sin(\phi - \lambda)$ is the orthogonal projection of p' on the line of

nodes, and this is evidently greatest in the position represented in the figure, viz., that in which GT is parallel to the line of nodes. But P is the position in the orbit corresponding to this position of p': so we see that the velocity in the line of sight is always a maximum when the body is passing through the line of nodes.

Therefore, to find when k is greatest, it is only necessary to have a circle drawn on carefully-squared paper, such as *papier millométrique*, of say 100 mm. radius. Take GF' equal to as many millomètres as there are units of the second decimal in the eccentricity. Draw the line GT, making an angle equal to λ with the line of apsides. Join TF', and produce it to T'. Then measure the distance of F' from the circumference of the circle at right angles to the line of apsides: this gives us $\frac{b}{a}$; also measure $F'T = \frac{p'}{a}$, and $F'T' = \frac{p}{a}$, and $\angle\, GTF' = \frac{\varpi}{2} - (\phi - \lambda)$. Then we have

$$\Pi V = \frac{la \cdot \frac{b}{a}}{P \frac{p}{a}} \sin(\phi - \lambda) \sin\gamma = \frac{la \,.\, F'B \,.\cos GTF'}{P \,.\, F'T'} \sin\gamma$$

$$= \frac{l \,.\, a \,.\, \frac{p'}{a}}{P \,.\, \frac{b}{a}} \,.\, \sin(\phi - \lambda) \sin\gamma = \frac{l \,.\, a \,.\, F'T \cos GTF'}{P \,.\, F'B} \sin\gamma .$$

For instance, in the case of 6 p Eridani, I find in Houzeau's *Vade Mecum de l'Astronome* the elements of the orbit to be—

$$\gamma = 44^\circ \;\; 40',$$
$$\lambda = 327^\circ \; 15',$$
$$\epsilon = 0\cdot378,$$
$$a = 3''\cdot82,$$
$$P = 117\cdot51\,;$$

and the periastron passage took place in 1817.51. I take $GF' = 37\cdot8$ mm. Measuring the distance $F'B$ above and below the focus, I find—

$$0\cdot926 \qquad \frac{p'}{a} = 1\cdot333$$

$$0\cdot929 \qquad \frac{p}{a} = 0\cdot642 \qquad \frac{\varpi}{2} - (\phi - \lambda) = 8^\circ\cdot8.$$

$$\frac{b}{a} = 0\cdot9275$$

$$\begin{array}{lll}
\text{Then}\ \log l & = 1\cdot2665 & \\
\log a & = 0\cdot5821 & \\
\log\sin(\phi-\lambda) & = 9\cdot9949 & \\
\log\sin\gamma & = \underline{9\cdot8469} & \\
 & \ 1\cdot6904 & \phantom{\log\frac{p'}{a} =}\ 1\cdot6904 \\
\log\frac{b}{a} & = \underline{9\cdot9673} & \log\frac{p'}{a} = \underline{0\cdot1249} \\
\log la\frac{b}{a}\sin(\phi-\lambda)\sin\gamma & = 1\cdot6577 & 1\cdot8153 = \log la\frac{p'}{a}\sin(\phi-\lambda)\sin\gamma \\
\log P & = 2\cdot0701 & \phantom{\log\frac{b}{a} =}\ 2\cdot0701 \\
\log\frac{p}{a} & = \underline{9\cdot8075} & \log\frac{b}{a} = \underline{9\cdot9673} \\
\log\frac{Pp}{a} & = 1\cdot8776 & 2\cdot0374 = \log\frac{Pb}{a}. \\
\therefore\ \log\Pi V & = 9\cdot7801 & 9\cdot7779 = \log\Pi V. \\
\Pi V & = 0\cdot6026 & 0\cdot5996 = \Pi V.
\end{array}$$

Or, finally, $$\Pi V = 0\cdot601.$$

If it be required to find the time at which ΠV attains this value, we have $\theta = \lambda = 327° 15'$, and from equations (1) and (2) we can find t. I have added below the values of k for a number of stars the elements of whose orbits are taken chiefly from Houzeau's *Vade Mecum*. I would draw attention to the results in the cases of Sirius and α Centauri, for which k is found to be 5·40 and 6·02 respectively. Now these numbers, even if we had had no knowledge otherwise of their parallaxes, would have pointed to these stars as being within measurable distance, and seem to show that in the case of α Centauri spectroscopic observations might have been employed in the year 1879 to test the measures of parallax made up to that time, since from these figures, taking its parallax, as determined by Gill and Elkin, as $0''\cdot75$, it must have been moving in the line of sight with a velocity of eight miles per second in April of that year. In the case of Sirius, although the value I have found for k, taken in conjunction with the value $0''\cdot4$ for its parallax, would show that in September, 1890, the companion will be moving with a velocity of thirteen miles per second in the line of sight, the great difference in the magnitudes of the components would, I fear, preclude the possibility of applying the spectroscopic test.

Out of this list of thirty-nine stars there are five for which the value of ΠV exceeds unity, namely, η Cassiopeæ, α Canis Majoris, α Centauri, 70 p Ophiuchi, and γ Coronæ Australis; and of these five no less than

four have been found to have a parallax greater than one-tenth of a second, viz.:

η Cassiopeæ, .	0·154,	. O. Struve, . . .	. 1856
α Canis Majoris,	0·389,	. Gill and Elkin,	. 1884
	0·273,	. Abbe, ...	. 1868
	0·193,	. Gyldén, ...	. 1864
α Centauri, . .	0·741,	. Gill and Elkin,	. 1884
	0·512,	. Elkin, ...	. 1880
	0·88,	. Moesta, ...	. 1868
	0·976,	. C. A. F. Peters,	. 1852
	0·919,	. Maclear, . . .	. 1851
70 p Ophiuchi, .	0·162,	. Krueger, . . .	. 1863

while with regard to the fifth, γ Coronæ Australis, I am not aware of any measures having been made with the view of determining its parallax. The value 1·224 for ΠV shows, however, that either it has a sensible parallax, or that in the year 1880 its motion in the line of sight was more than twelve miles a second. The quantity ΠV attains a second maximum in June of this year, reaching the value 0·857 : so that, if the parallax should prove to be very small, we might expect to see some displacement of the lines in the spectrum which would enable us to obtain a measure of its amount. As the distance will be then $1''\cdot 5$, and the components are equal in magnitude, the circumstances are rather favourable for the detection of such a displacement.

The system 40 or o_2 Eridani is composed of three stars. The primary (A), of 4·4 magnitude, and a companion double star (B, C), of magnitudes $9\frac{1}{2}$ and $10\frac{1}{2}$ respectively, distant $82''$ from A. That they belong to one system seems certain, from the fact that they all have a common proper motion amounting to no less than $4''\cdot 10$ annually. The elements of the pair B, C have been computed by Mr. Gore, and published in the *Monthly Notices* of the Royal Astronomical Society, for March of this year. From these elements I find that ΠV is equal to 0·886. This, taken in connexion with Dr. Gill's determination of its parallax, which he finds to be $0''\cdot 166$, shows that this is a slowly-moving pair, as its velocity in the line of sight can never exceed five and a-half miles per second. If, however, at any time the orbit of the companion pair around the primary should be found capable of computation, we might reasonably expect that with such an apparent distance as $82''$ the linear relative velocity would become measurable with the spectroscope.

Star.	Π*V*.	Star.	Π*V*.
η Cassiopeæ, ...	1·247	η Coronæ Borealis, . .	0·392
36 Andromedæ, . . .	0·105	μ_2 Bootis, ...	0·073
6 *p* Eridani, ...	0·601	298 Otto Struve, . . .	0·331
α Canis Majoris, . . .	5·400	γ Coronæ Borealis, . .	0·174
1037 Struve, ...	0·278	51 (ξ) Libræ, ...	0·227
α Geminorum, ...	0·090	σ Coronæ Borealis, . .	0·125
ζ Cancri, ...	0·086	λ Ophiuchi, ...	0·055
3121 Struve, ...	0·432	ζ Herculis, ...	0·605
ω Leonis, ...	0·202	μ_2 Herculis, ...	0·581
ϕ Ursæ Majoris, . . .	0·148	τ Ophiuchi, ...	0·135
γ Leonis, ...	0·153	70 *p* Ophiuchi, . . .	1·270
ξ Ursæ Majoris, . . .	0·895	γ Coronæ Australis, . .	1·224
γ Virginis, ...	0·624	δ Cygni, ...	0·083
42 Comæ Ber., . . .	0·479	4 Aquarii, ...	0·122
1757 Struve, ...	— ?	ζ Aquarii, ...	0·121
25 Canum Venaticorum,	— ?	3062 Struve, ...	0·138
1819 Struve, ...	0·066	β Delphini (Gore), . .	0·363
α Centauri, ...	6·023	,, (Doubiago),	0·463
ξ Bootis, ...	0·800	40 Eridani, ...	0·886
44 *i* Bootis, ...	0·500	234 Otto Struve, . . .	0·086

XLII.—Authenticated Materials towards a Land and Freshwater Molluscan Fauna of Ireland. By John W. Taylor and W. Denison Roebuck, F.L.S. [Communicated by W. F. de Vismes Kane, M.R.I.A.]

[Read, June 28, 1886.]

During the past year or two we have been favoured by several friends with interesting consignments of Mollusca from various parts of Ireland, and in particular we are indebted to our friend Mr. W. F. de Vismes Kane, whose kindness in collecting and sending to us specimens of Irish slugs from various counties has been of much service to us in our work of monographing the British Land and Freshwater Mollusca —by indicating that the Irish Fauna has in this department of Natural History a tendency to the development of a character somewhat diverse from that of Britain, or perhaps, to speak more correctly, from that of England. This being so, it is desirable that the Molluscan Fauna of Ireland should be worked out in more detail than has hitherto been done, and that we—having in course of preparation a new monograph of the British Land and Freshwater Mollusca based upon an extensive and elaborate plan—should have the opportunity of seeing specimens from every county and district of the island. It seemed to us, therefore, that an account of what we know up to the present moment from actual inspection of specimens would be of some service, both as a contribution to a new fauna of Ireland, and as an indication to Irish Naturalists of the nature and character of the assistance we should like to receive at their hands. We may say, moreover, that the plan of our proposed work, being an exhaustive and detailed one, renders it impossible for us to see too many specimens; and as the detailed study of minute variation enters as a principal factor, it is desirable that we should have extensive consignments of the commonest and most prevalentspecies, in addition to the rare and special ones, as being more likely to furnish us with suitable and adequate material for study.

We are not yet in a position to institute a comparison with the works of Thompson, Clarke, and other famous Irish Naturalists, further than to say that we have had submitted to us examples of nearly all the species which appear in their lists, and that the additions we have to make are but three in number, all slugs. The first is *Testacella maugei*, the second is *Limax cinereo-niger*, and the third is *Arion subfuscus*. The last of these is one which we have recently satisfied ourselves, from the anatomical observations of our friend Mr. Charles Ashford of Christchurch, should be added to the British list. It is as common in the British Isles as on the continent, and has hitherto been confounded by British Naturalists with the other species of Arion. *Limax cinereo-niger* is a fine and conspicuous species, very distinct

from *L. maximus*, with which it has hitherto been confounded. The Rev. B. J. Clarke met with it in Ireland, as is clear from his writings in 1843; but it is only of recent years that it has been ranked by name as a member of the British Fauna. It is, however, a very rare species, and has as yet only turned up in solitary examples. There is reason to suspect that it is in these islands a species which affects the western and northern regions, the regions of a high average rainfall, judging from its known Continental range, and the nature of the British localities which have as yet afforded it. *Limax arborum* is a species of apparently similar tendencies in its range, and one which seems to be commoner in Ireland and Scotland, and the hill districts of Wales and North England, than it is in the English midland, southern and eastern counties.

With regard to the other Mollusca included in the list, it is to be observed how remarkable it is that *Bulimus acutus*, which is, in Great Britain, strictly confined to the coast-line, being nowhere found more than a few hundred yards from the sea, should in Ireland occur in inland localities, even so far inland as Athlone—a tendency which has already been noticed by Mr. Thompson.

We may conclude these introductory remarks by stating that we should be glad if Irish Naturalists—whether they are conversant or not with the Mollusca—will assist us by sending us specimens from every Irish district possible, in order that we may be able to advance at one and the same time a knowledge of the Irish species, and of the variation and distribution of our British ones. Consignments may be addressed to John W. Taylor, Office of the *Journal of Conchology*, Hunslet New Road, Leeds, or W. Denison Roebuck, Sunny Bank, Leeds.

Testacella maugei, v. viridans, Morelet.

Waterford.—Two specimens sent, Sept. 21, 1883, from a nursery garden at Waterford.—*J. H. Salter.*

It is noteworthy that these—the only Irish specimens of *T. maugei* that we have seen—should differ completely in colour from the English examples, and should resemble the common form which, according to Morelet, occurs in Portugal.

Arion ater, L.

Down.—Newcastle, one, typical, Oct. 17, 1884.—*Rev. H. W. Lett.*

Arion ater, v. brunnea, var. nov., Roebuck.

Character:—Colour, deep brown.—*W. Denison Roebuck.*

Sligo.—Collooney, three, half grown, Sep. 15, 1885.—*W. F. de V. Kane.*

Armagh.—Several of varying size, sent from the county, June 15, 1885; one had an orange foot-fringe; in the others it was sienna.—*Rev. H. W. Lett.*

Arion ater, v. brunnea, var. nov., Roebuck (*continued*):

Down.—Newcastle, a few, in colouration extremely dark red-brown, resembling that of the *L. arborum* found with them, October 17, 1884.—*Rev. H. W. Lett.*

Mayo W.—Enniscoe Demesne, near Crossmolina. Two adults sent Sept. 19, 1885, by W. F. de V. Kane, another Sept. 24th.—*Id.*

Waterford.—Two specimens sent from near Waterford, Sept. 21, 1883, of a very deep chocolate-brown tint.—*J. H. Salter.*

Arion ater, v. bicolor, Moq.

Waterford.—Several very fine specimens, sent Sept. 21, 1883, collected in a very wet part of a small bog at Ballygunner. —*J. H. Salter.*

Dublin.—Several, very fine and characteristic, from near Dublin, March 31, 1886.—*J. R. Redding.*

Arion ater, v. succinea, Müll.

Mayo W.—Enniscoe Demesne, near Crossmolina, Sept. 19, 1885. one small. Sept. 24, one, nearly adult, of bright orange-yellow, with faint band-shadowings.—*W. F. de V. Kane.*

Arion ater, v. pallescens.'

Armagh.—A very small specimen sent from this country June 15, 1885.—*Rev. H. W. Lett.*

Arion ater v. plumbea, Roeb.

Mayo W.—Enniscoe Demesne, Crossmolina, Sept. 19, 1885, one, adult, very deep colour.—*W. F. de V. Kane.*

Arion ater, v. nigrescens.

Antrim.—Colin Glen, near Belfast, one, very young, June 10, 1884.—*S. A. Stewart.*

Down.—Slieve Donard, one, at 1500 feet alt., Sept. 20, 1884.—*Rev. H. W. Lett.*

Arion subfuscus.

Sligo.—Collooney, two, Sept. 15, 1885; adult; pale ochre yellow, with bands sub-obsolete and just visible.—*W. F. de V. Kane.*

Armagh.—Eight sent from the county, June 15, 1885; warm rich sienna-brown in tint, two of them rather more sober brown.—*Rev. H. W. Lett.*

Mayo W.—Enniscoe Demesne, Crossmolina, Sept. 19, 1885, an adult specimen, sober ochre-brown in colour, with the bands shadowy but distinct.—*W. F. de V. Kane.*

Arion hortensis, Fér.

Waterford.—Near Waterford, Sept. 21, 1883; several.—*J. H. Salter.*

Geomalacus maculosus, Allman.

The only specimen we have ever seen of this most interesting species was a dried one in the possession of Mr. William Cash, F.G.S., of Halifax. It was from the well-known locality, Lough Carogh, near Killarney. We should be very pleased if some Irish Naturalist would assist us by sending us living specimens, in order that they may be figured and described.

Amalia marginata, Müll.

Waterford.—Near Waterford; several sent Sept. 21, 1883; the specimens varied in colour, the dark ones being from a garden, the others from under stones by the river.—*J. H. Salter.*

Limax cinereo-niger, Wolf.

Kerry.—A young specimen, uniform grey-black in colour, with the keel a shade paler, was sent to us by Mr. W. F. de V. Kane on the 28th of June, 1885, which he had taken that day near the Upper Lake, Killarney.

Sligo.—Near Markree Castle, one, adult, typical; 155 mm. long when crawling; black, but not perfectly unicolorous, having a thin whitish keel-line, which does not extend above the keel, and the animal possesses some faint band-traces.—*W. F. de V. Kane.*

Limax maximus, L.

Waterford.—Near Waterford, Sept. 21, 1883, a few typical examples.—*J. H. Salter.*

Limax maximus, v. ferussaci, Moq.

Antrim.—Colin Glen, near Belfast; one, adult; June 10, 1884.—*S. A. Stewart.*

Armagh.—One sent from Co. Armagh, June 15, 1885; 95 mm. in length.—*Rev. H. W. Lett.*

Limax maximus, v. fasciata, Moq.

Sligo.—Collooney, Sept. 15, 1885, one, very dark-coloured, almost black, the light spaces, almost obliterated, the shield distinctly marbled; length at full stretch, 75 mm.—*W. F. de V. Kane.*

Mayo W.—Enniscoe Demesne, near Crossmolina, Sept. 19, 1885; three half-grown examples sent.—*W. F. de V. Kane*; one from same place, Sept. 24.—*Id.*

Limax flavus, L.

Waterford.—Near Waterford, Sept. 21, 1883, several, typical; one of the smallest and youngest was, however, the darkest specimen we have yet seen.—*J. H. Salter.*

Dublin.—In one of the stores, Henry place, Dublin, Feb. 9, 1886. —*J. R. Redding.*

Limax arborum, B.-Ch.

Mayo W.—Enniscoe Demesne, near Crossmolina, Sept. 19, 1885, two, adult, typical.—*W. F. de V. Kane;* two more sent on the 24th.—*Id.*

Clare.—Mr. Rogers showed us in his collection shells of this species.

Limax arborum, var. nemorosa, Baud.

Kerry.—Mr. W. F. de V. Kane sent us, along with *L. cinereo-niger*, a series of eight specimens of this variety from the vicinity of the Upper Lake at Killarney, collected on the 28th of June; one was a very characteristic specimen, and all the others approached it in a more or less marked degree.

Waterford.—Near Waterford, Sept, 21, 1883; one.—*J. H. Salter.*

Tyrone.—Abundant at Creaghan Wood, near Aughnacloy. Two sent August 14, 1885.—*W. F. de V. Kane.*

Sligo.—Markree Castle; two, adult, Sept. 15, 1885.—*W. F. de V. Kane.*

Mayo W.—Enniscoe Demesne, near Crossmolina, Sept. 19, 1885; one immature, deep brown in colour, with black bands.—*W. F. de V. Kane.*

Limax arborum, var. bettonii, Sordelli.

Mayo W.—Enniscoe Demesne, Crossmolina, Sept. 19, 1885, three; Sept. 24, three.—*W. F. de V. Kane.*

Limax arborum, var. maculata, Roeb.

Mayo W.—Enniscoe Demesne, Crossmolina, one, adult, on the 19th, and one, not quite grown, on the 24th Sept, 1885.—*W. F. de V. Kane.* These were the types on which this new and well-marked variety was founded.

Limax arborum, var rupicola, Lessona.

Down.—Newcastle, one sent, Oct. 17, 1884, by *Rev. H. W. Lett;* it agreed in everything with Lessona's description of this variety, except that the keel was of the normal length. This specimen was in colour black-brown, with the shield nearly unicolorous, and the pale dorsal line nearly obsolete.

Limax agrestis, L.

Donegal.—Donegal, Sept. 7, 1885.—*W. F. de V. Kane.*

Waterford.—Near Waterford, Sept. 21, 1883, several.—*J. H. Salter.*

Mayo W.—Enniscoe Demesne, near Crossmolina, Sept. 24, 1885, one.—*W. F. de V. Kane.*

Limax agrestis, v. sylvatica, Moq. (not Drap.)

Antrim.—Colin Glen, near Belfast, one, adult, June 10, 1884.—*S. A. Stewart.*

Armagh.—Several sent from this county, June 15, 1885, with the markings nearly black.—*Rev. H. W. Lett.*

Mayo W.—Enniscoe Demesne, Sept. 24, 1885, three.—*W. F. de V. Kane.*

Succinea putris, L.

Kerry.—Muckross, 1867.—*J. R. Hardy.*

Tipperary S.—Near Clonmel, a few.—*A. H. Delap.*

Succinea elegans, Risso.

Tipperary S.—A few near Grantstown.—*R. Rimmer.* Near Clonmel.—*A. H. Delap.*

Kerry.—Killarney.—*T. Rogers.*

Succinea oblonga, Drap.

Cork S.—Ballincollig.—Coll. *W. Cash.*

Vitrina pellucida, Müll.

Galway W.—Subfossil, Dog's Bay, Roundstone, Oct. 1867.—*R. D. Darbishire.*

Tipperary S.—Clonmel, one.—*A. H. Delap.*

Zonites cellarius, Müll.

Waterford.—Near Waterford, Sep. 21, 1883; very numerous.—*J. H. Salter.*

Tipperary S.—Grantstown, a few.—*R. Rimmer.* Near Clonmel. —*A. H. Delap.*

Mayo W.—Enniscoe Demesne, Crossmolina, Sept. 24, 1885; numerous.—*W. F. de V. Kane.*

Zonites alliarius, Miller.

Tipperary S.—Near Clonmel, one, juv.—*A. H. Delap.*

Zonites alliarius, var. viridula, Jeff.

Derry.—Coleraine, common, April, 1884.—*L. E. Adams.*

Zonites nitidulus, Drap.

Derry.—Coleraine, common, Dec. 1883.—*L. E. Adams*.

Galway W.—Subfossil at Dog's Bay, Roundstone, Oct. 1865.—*R. D. Darbishire*.

Tipperary S.—Grantstown, one, June 26, 1885.—*R. Rimmer*.

Zonites nitidulus, v. helmii, Alder.

Tipperary S.—Grantstown, one, June 26, 1885.—*R. Rimmer*.

Zonites purus, Alder.

Derry.—Coleraine, spring, 1884, common in woods and under stones.—*L. E. Adams*.

Zonites purus, v. margaritacea, Jeff.

Derry.—Coleraine, spring, 1884, with type, but far more common. —*L. E. Adams*.

Tipperary S.—Grantstown, one, June 26, 1885.—*R. Rimmer*.

Zonites radiatulus, Alder.

Derry.—Coleraine, numerous in a hedge-bank under stones, March, 1884.—*L. E. Adams*.

Tipperary S.—Grantstown, one.—*R. Rimmer*.

Kerry.—Killarney.—*T. Rogers*.

Z. radiatulus, v. viridescenti-alba, Jeff.

Derry.—Coleraine, three, March, 1884.—*L. E. Adams*.

Zonites excavatus, Bean.

Kerry.—Muckross.—*J. R. Hardy*.

Zonites excavatus v. vitrina, Fér.

Dublin.—Dublin.—*A. M. Norman* (from *W. W. Walpole*).

Zonites crystallinus, Müll.

Derry.—Coleraine, very common, April, 1884.—*L. E. Adams*.

Galway W.—Subfossil at Dog's Bay.—*R. D. Darbishire*.

Tipperary S.—Near Clonmel.—*A. H. Delap*.

Kerry.—Muckross, 1867.—*J. R. Hardy*.

Zonites fulvus, Müll.

Derry.—Coleraine, common in November, 1883, in moss and on decaying leaves in a small wood close to the railway at Ballycairns farm.—*L. E. Adams*.

Kerry.—Muckross.—*J. R. Hardy*.

Tyrone.—Tyrone, from *E. Waller*, in coll. *A. M. Norman*.

Helix lamellata, Jeff.

Tipperary S.—Near Clonmel.—*A. H. Delap*.

Kerry.—Muckross, 1867.—*J. R. Hardy*.

Helix aculeata, Müll.

Derry.—Coleraine, moderately common in a little wood close to the railway at Ballycairns farm, Dec., 1883—*L. E. Adams.*

Kerry.—Muckross.—*J. R. Hardy.*

Helix aculeata v. albida, Jeff.

Kerry.—Muckross.—*J. R. Hardy.*

Helix aspersa, Müll.

Donegal.—Donegal, one, immature, Sept. 7, 1885.—*W. F. de V. Kane.*

Antrim.—Ballintoy, one.—*Rev. Canon J. Grainger* (per *S. C. Cockerell*).

Dublin.—Killester-lane, Artane, near Dublin.—*J. R. Redding.*

Tipperary S.—Grantstown, one.—*R. Rimmer.*

Helix nemoralis, L.

King's Co.—Clara.—*C. Ashford.*

Galway W.—Gorteen, Connemara, very numerous, bleached, and subfossil.—*T. Rogers.*

Clare.—Clare coast, *T. Rogers;* ruins of Corcomroe Abbey.—*T. Rogers.*

The above are records in which, contrary to our usual practice, no notice is taken of the variation. Those in which the variation has been noted may be tabulated, thus:—

Helix nemoralis, L.

Varietal Name and Band-formula.		Locality, Habitat, &c.
,, libellula 00000	Down.	Newcastle, one, immature, and much abraded, Oct. 17, 1884.—*Rev. H. W. Lett.*
,,	Donegal.	Donegal, one, immature, Sept. 7, 1885.—*W. F. de V. Kane.*
,,	Dublin.	Dublin, one.—*J. R. Redding.*
,,	Galway, W.	Gorteen, Connemara, numerous subfossil specimens—one of them an umbilicated shell.—*T. Rogers.*
,,	Clare.	Coast of Clare, five.—*T. Rogers.*
,,	Kerry.	Near upper lake, Killarney, one adult, June 23, 1885.—*W. F. de V. Kane.*
,, libellula 00000 sinistrorsum	Donegal.	Bundoran, one, from E. Waller.—*In coll. Rev. A. M. Norman.*

Helix nemoralis, L. (*continued*):

Varietal Name and Band-formula.		Locality, Habitat, &c.
„ libellula 00300	Down.	Newcastle, one adult and two immature, Oct. 17, 1884, almost denuded of epidermis.—*Rev. H. W. Lett.*
„	Galway W.	Gorteen, Connemara, numerous, subfossil, bleached perfectly white.—*T. Rogers.*
„	Clare.	County Clare, five.—*T. Rogers.*
„ libellula 00345	„	County Clare, one, with the bands blotchy.—*T. Rogers.*
„ libellula 02345	„	County Clare, three.—*T. Rogers.*
„ libellula 12045 sinistrorsum	Donegal.	Bundoran, one, from E. Waller.—*Coll. Rev. A. M. Norman.*
„ libellula 12345	„	Donegal, two, with bands very blotchy, pale in one, in the other dark throughout, and very black and all united at the mouth.—*W. F. de V. Kane.*
„	„	Donegal, one Sept. 7, 1885.—*W. F. de V. Kane.*
„	Dublin.	Dublin, one.—*J. R. Redding.*
„	Clare.	Coast of Clare, one.—*T. Rogers.*
„	Tipp. Sth.	Grantstown, one, June 26, 1885.—*R. Rimmer.*
„ libellula 12345 sinistrorsum	Donegal.	Bundoran, one, from E. Waller.—*Coll. Rev. A. M. Norman.*
„ libellula (12)345 albolabiata	Kildare.	Kildare.—*R. M. Christy.*
„ libellula (12)345	Clare.	Ruins of Corcomroe Abbey, one.—*T. Rogers.*
„ libellula 1(23)45	Tipp. Sth.	Grantstown, one, June 26, 1885.—*R. Rimmer.*
„ libellula 1(23)45 roseolabiata	Kerry.	Near the upper lake, Killarney, one adult, June 23, 1885, with the bands light brown, intensified in colour at irregular intervals, 1(2345) at mouth.—*W. F. de V. Kane.*
„ libellula (12)3(45)	Down.	Newcastle, one, immature, bands blotchy, Oct. 17, 1884.—*Rev. H. W. Lett.*

Helix nemoralis, L. (*continued*):

Varietal Name and Band-formula.		Locality, Habitat, &c.
,, libellula (123)45	Dublin.	Malahide, one, epidermis, much abraded by friction on the sand-hills.—*J. E. Palmer.*
,, libellula (123)(45)	,,	Malahide, one, epidermis abraded. —*J. E. Palmer.*
,,	Donegal.	Donegal, one, with bands dark brown.—*W. F. de V. Kane.*
,,	Clare.	Ruins of Corcomroe Abbey, one.—*T. Rogers.*
,, libellula (1234)5	Dublin.	Dublin, one—*J. R. Redding.*
,, libellula (12345)	Clare.	County Clare, three.—*T. Rogers.*
,,	,,	Ruins of Corcomroe Abbey, one.—*T. Rogers.*
,,	,,	Coast of Clare, one, with bands pale and blotchy.—*T. Rogers.*
,, castanea 00000	Dublin.	Malahide, sandhills, several, epidermis abraded.—*J. E. Palmer.*
,,	Tipp. Sth.	Clonmel.—*A. H. Delap.*
,, carnea 00000	Dublin.	Malahide, several, with abraded epidermis—*J. E. Palmer.* Green-lanes, Dollymount, one, very peculiar dead pink colour.—*J. R. Redding.*
,, carnea 12345	,,	Dublin, one.—*J. R. Redding.*
,, carnea 1(23)45 vinosofasciata	,,	Near Dublin, one.—*J. R. Redding.*
,, rubella 00300	,,	Malahide, three, band very broad, epidermis abraded.—*J. E. Palmer.*
,,	Kerry.	Near upper lake, Killarney, one adult, June 23, 1885.—*W. F. de V. Kane.*
,,	Mayo W.	Enniscoe demesne, Crossmolina, one, juv., Sept. 24, 1885.—*W. F. de V. Kane.*
,, rubella 00345	Dublin.	Dublin, two, bands blotchy.—*J. R. Redding.*
,, rubella 12345	,,	Dublin, three, bands blotchy.—*J. R. Redding.*
,, rubella 1(23)45	Donegal.	Donegal, Sept. 7, 1885, bands black.—*W. F. de V. Kane.*
,, rubella (12345)	,,	Donegal, Sept. 7, 1885, bands black.—*W. F. de V. Kane.*

Helix hortensis, Müll., **var. lutea 00000.**

Kildare.—Kildare, two.—*R. M. Christy.*

These are the only specimens of this species we have ever seen from Ireland.

Helix rufescens, Penn.

Donegal.—Donegal, numerous, Sept. 7, 1885.—*W. F. de V. Kane.*

Dublin.—Green-lanes, Dollymount, near Dublin, and Killester-lane, Artane village, July 5, 1885.—*J. R. Redding.*

Tipperary S.—Grantstown, a few.—*R. Rimmer.*

Cork N.—Cork.—*Rev. J. W. Horsley* (per *S. C. Cockrell*).

Kerry.—Muckross.—*J. R. Hardy.* Killarney.—*T. Rogers.*

Helix rufescens, v. rubens, Moq.

Tipperary S.—Grantstown, one.—*R. Rimmer.* Near Clonmel.—*A. H. Delap.*

Cork N.—Near Cork.—*Rev. J. W. Horsley* (per *S. C. Cockerell*).

Helix concinna, Jeff.

Derry.—Coleraine, common.—*L. E. Adams.*

Tipperary S.—Grantstown, a few.—*R. Rimmer.*

Helix concinna, v. albida, Jeff.

Derry.—Coleraine, one or two specimens in damp places, April, 1884.—*L. E. Adams.*

Helix hispida, L.

Clare.—County Clare.—*T. Rogers.*

Helix sericea, Müll.

Kildare.—Kildare.—*T. Rogers.*

Helix fusca, Mont.

Antrim.—Cave Hill, near Belfast, August 29, 1883.—*S. A. Stewart.*

Sligo.—Enniscoe Demesne, two sent.—*W. F. de V. Kane.*

Helix pisana, Müll.

Dublin.—Sandhills, Rush, abundant, Sept. 24, 1885.—*J. R. Redding.* Dublin.—*A. M. Norman.*

Helix pisana, v. alba, Shuttl.

Dublin.—Sandhills, Rush, with type, common.—*J. R. Redding.* In the Rev. Dr. Norman's collection we saw a specimen with transparent bands, which he had received from Dr. Kinahan.

Helix virgata, Da Costa.

Dublin.—Killester lane, Artane village, Sept. 24, 1885.—*J. R. Redding.* Sandhills, North Bull, Dollymount, June 6, 1885. —*J. R. Redding.* Green-lanes, Dollymount, July 7, 1885.— *J. R. Redding.* Sandhills, Rush, Sept. 24, 1885.—*J. R. Redding.* Dublin.—Coll. *A. M. Norman*, and *Alder Collection.*

Kildare.—Kildare.—*T. Rogers.*

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Kerry.—Muckross.—*J. R. Hardy.*

Helix virgata, v. maculata.

Dublin.—Sandhills, Rush, two, Sept. 24, 1885.—*J. R. Redding.*

Helix virgata, v. albicans, Grat.

Dublin.—Sandhills, North Bull, Dollymount.—*J. R. Redding.* Killester lane, Artane village.—*J. R. Redding.* Clontarf.— *T. Rogers.*

Kildare.—Kildare.—*T. Rogers.*

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Helix virgata, v. alba, Tayl.

Galway W.—Galway.—*W. Nelson.*

Dublin.—Common in a clover field, Killester lane, Artane.—*J. R. Redding.*

Helix virgata, v. leucozona, Tayl.

Dublin.—Sandhills, Rush, common, Sept. 1885.—*J. R. Redding.*

Helix virgata, v. nigrescens, Grat.

Dublin.—Near Dublin, light-brown in colour.—*Alder Coll.* (from *T. W. Warren*).

Helix caperata, Mont.

Derry.—Coleraine, common (one of the specimens measures 11mm. in diameter).—*L. E. Adams.*

Dublin.—Wharf-road, Dublin, one, June 6, 1885.—*J. R. Redding.*

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Helix caperata, v. subscalaris, Jeff.

Derry.—Coleraine, a few.—*L. E. Adams.*

Helix caperata, v. ornata, Pic.

Derry.—Coleraine, one, with type and v. *subscalaris.*—*L. E. Adams.*

Tipperary S.—A ditch near the "Giant's Grave", Clonmel, a few.—*A. H. Delap.*

Helix caperata, var. fulva, Moq.

Tipperary S.—A ditch near the "Giant's Grave", Clonmel, one. —*A. H. Delap.*

Helix ericetorum, Müll.

King's Co.—Clara.—*C. Ashford.*

Wexford.—Courtown.—*J. W. Cundall.*

Derry.—Coleraine, common on the sandhills.—*L. E. Adams.*

Antrim.—Portrush, exceedingly abundant on the sandhills, feeding on thistles.—*R. D. Darbishire.*

Galway W.—Subfossil at Roundstone.—*R. D. Darbishire;* and at Gorteen, Connemara.—*T. Rogers.*

Clare.—Blackhead.—*T. Rogers.*

Tipperary S.—Grantstown, a few.—*R. Rimmer.* Near Clonmel. —*A. H. Delap.*

Donegal.—Milford Sandhills, one.—*R. M. Christy.*

Helix ericetorum, var. leucozona, Moq.

Donegal.—Milford sandhills, numerous.—*R. M. Christy.*

Helix ericetorum v. instabilis, Ziegl.

Dublin.—Phœnix Park.—*Alder Coll.*

Helix ericetorum v. deleta, Moq.

Derry.—Coleraine, with type.—*L. E. Adams.*

Tipperary S.—Near Clonmel, one approaching this variety.—*A. H. Delap.*

Helix ericetorum v. monozona, Pascal.

Derry.—Coleraine, with type, one.—*L. E. Adams.*

Helix ericetorum v. alba, Charp.

Derry.—Coleraine, with type, common.—*L. E. Adams.*

Clare.—Blackhead.—*T. Rogers.*

King's Co.—Clara.—*C. Ashford.*

Donegal.—Milford Sandhills, two.—*R. M. Christy.*

Helix rotundata, Müll.

Derry.—Coleraine, numerous, found under stones by the river Bann, which are submerged at high water, though perhaps not by *every* tide.—*L. E. Adams.*

Sligo.—Markree Castle Demesne, a few, Sept. 15, 1885.—*W. F. de V. Kane.*

Tipperary S.—Grantstown, a few.—*R. Rimmer.* Near Clonmel. —*A. H. Delap.*

Helix rotundata, v. pyramidalis, Jeff.

Derry.—Some of the Coleraine examples approach this variety.

Helix rotundata, v. alba.

Derry.—A single dead shell in the rejectamenta on the Bann side, near Coleraine, May, 1884.—*L. E. Adams.*

Helix rupestris, Drap.

Tipperary S.—Grantstown, a few.—*R. Rimmer.*

Cork N.—Cork, May, 1885.—*Rev. J. W. Horsley* (per *S. C. Cockerell*).

Kerry.—Torc Waterfall, near Killarney.—*J. R. Hardy.*

Helix pygmæa, Drap.

Derry.—Coleraine, common on decaying leaves, in a little wood close to the railway at Ballycairns farm, Dec. 1883.—*L. E. Adams.*

Helix pulchella, Müll.

Galway W.—Subfossil at Dog's Bay, Roundstone, Oct. 1867.—*R. D. Darbishire.*

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Bulimus acutus, Müll.

Antrim.—Portrush.—*R. D. Darbishire.*

Westmeath.—Athlone, abundant on the grassy slopes of the earthworks which it is understood were made during the potato famine as a means of providing work for the people.—*T. Rogers.*

Dublin.—Dublin Castle.—*J. R. Redding.* Sandhills, North Bull, Dollymount, abundant, June, 6, 1885.—*J. R. Redding.* Sandhills, Rush, abundant, Sept. 24, 1885.—*J. R. Redding.*

Wexford.—Courtown.—*J. W. Cundall.*

Donegal.—Lough Swilly.—*Alder Collection.*

Tipperary S.
Waterford
Very abundant around Clonmel, on both banks of the Suir, along the tow-path, Fethard-road, Cashel-road, Cahir-road, &c., in fact on *any* bare ditch or bank near Clonmel, which is about twenty miles distant from the sea.—*A. H. Delap.*

Derry.—Near Coleraine, common.—*L. E. Adams.*

Galway W.—Roundstone.—*W. W. Walpole* (per *C. Ashford*), and *R. D. Darbishire.*

Bulimus acutus v. bizona, Moq.

Derry.—Coleraine, a specimen with the two bands united.—*L. E. Adams.*

Dublin.—Dublin Bay.—*J. Hardy, Sen.* Rush, Sept. 24, 1885.—*J. R. Redding.*

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Bulimus acutus v. articulata, Lam.

Dublin.—Dublin Bay.—*J. Hardy, Sen.* Sandhills, Rush, Sept. 24, 1885.—*J. R. Redding.*

Bulimus acutus v. strigata, Menke.

Dublin.—Dublin.—*Alder Coll.* Killester-lane, village of Artane, a few, Sept. 20, 1885.—*J. R. Redding.*

Bulimus acutus v. alba, Req.

Dublin.—Dublin.—*Alder Coll.*

Bulimus acutus v. elongata.

Dublin.—Dublin.—*Alder Coll.*

Pupa umbilicata, Drap.

Kerry.—Muckross, 1867.—*J. R. Hardy.*

Cork S.—Glengariff.—*H. Bendall.*

Galway W.—Galway.—*Sunderland Museum.*

Donegal.—Killybegs.—*Sunderland Museum.*

Tipperary S.—Grantstown, a few.—*R. Rimmer.*

Cork N.—Cork, collected by Rev. J. W. Horsley.—*S. C. Cockerell.*

Pupa umbilicata v. albina, Moq.

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Pupa ringens, Jeff.

Kerry.—Muckross, abundant.—*J. R. Hardy.*

Pupa ringens v. pallida, Jeff.

Kerry.—Muckross, several pure white specimens, with type, 1867.—*J. R. Hardy.*

Pupa marginata, Drap.

Galway W.—Subfossil at Dog's Bay, Roundstone.—*R. D. Darbishire.*

Tipperary S.—Clonmel, a fragment.—*A. H. Delap.*

Kerry.—Muckross.—*J. R. Hardy.*

Vertigo antivertigo, Drap.

Dublin.—Dublin, from W. W. Walpole.—*A. M. Norman.*

Vertigo lilljeborgi, Westerl.

Galway W.—Ballinahinch, Connemara.—*J. G. Jeffreys* in coll. *A. M. Norman.*

Vertigo pygmæa, Drap.

Derry.—Coleraine, common among the drift on the sandhills, April, 1884.—*L. E. Adams.*

Kerry.—Torc Waterfall, near Muckross.—*J. R. Hardy.*

Vertigo pygmæa v. quadridentata, Stud.

Derry.—Coleraine, one, with type.—*L. E. Adams.*

Vertigo alpestris, Alder.

Derry.—Coleraine, a single specimen under a stone by the Bann, Nov. 1883.—*L. E. Adams.* This was seen by the late Dr. Jeffreys, who reported it as certainly *V. alpestris*, and an addition to the fauna of Ireland.

Vertigo substriata, Jeff.

Derry.—Coleraine, several specimens found in the drift in the sandhills at the mouth of the Bann.—*L. E. Adams.*

Vertigo pusilla, Müll.

Derry.—Coleraine, several, from the Sandhills at the Bann mouth.—*L. E. Adams.*

Vertigo augustior, Jeff.

Derry.—Coleraine, common in the drift at the mouth of the Bann.—*L. E. Adams.*

Galway W.—Connemara.—*R. D. Darbishire.*

Cork S.—Near Cork.—*J. G. Jeffreys* (*Alder Coll.*).

Sligo.—Killaney Glebe.—*Rev. A. M. Norman.*

Vertigo edentula, Drap.

Derry.—Coleraine, very common on decaying leaves, in a little wood close to the railway at Ballycairns farm, apparently gregarious under a log, Dec. 1883.—*L. E. Adams.*

Kerry.—Muckross.—*J. R. Hardy.*

Vertigo minutissima, Hartm.

Kerry.—Muckross.—*J. R. Hardy.*

Balea perversa, L.

Kerry.—Muckross.—*J. R. Hardy.* Killarney, very fine specimens.—*E. Collier.*

Clausilia rugosa, Drap.

Antrim.—Portrush and Cushendall.—*R. D. Darbishire.*

Sligo.—Enniscoe Demesne, near Crossmolina, numerous, Sept. 1885.—*W. F. de V. Kane.*

Galway W.—Subfossil at Dog's Bay, October, 1865.—*R. D. Darbishire.* Galway, *Sunderland Museum.*

Tipperary S.—Grantstown, a few—*R. Rimmer.* Near Clonmel.—*A. H. Delap.*

Cork N.—Near Cork, May, 1885.—*Rev. J. W. Horsley* (per *S. C. Cockerell*).

Cork S.—Bantry, numerous.—*H. Bendall.*

Kerry.—Killarney—*H. Bendall*, Oct. 1884. Muckross, Torc Falls, and Mangerton.—*J. R. Hardy.*

Clausilia rugosa v. tumidula, Jeff.

Tipperary S.—Grantstown, a few.—*R. Rimmer.*

Clausilia rugosa v. gracilior, Jeff.

Kerry.—Very abundant and characteristic at Muckross.—*J. R. Hardy;* one example measured 16 × 2¼ mm.

Cochlicopa lubrica, Müll.

Derry.—Common at Coleraine.—*L. E. Adams.*

Galway W.—Subfossil at Dog's Bay.—*R. D. Darbishire.*

Tipperary S.—Grantstown, a few sent.—*R. Rimmer.*

Kerry.—Muckross, near Killarney.—*J. R. Hardy.*

Cochlicopa lubrica v. hyalina, Jeff.

Derry.—Coleraine, one.—*L. E. Adams.*

Kerry.—Muckross.—*J. R. Hardy.*

Cochlicopa lubrica v. lubricoides, Fér.

Derry.—Coleraine, with type.—*L. E. Adams.*

Galway W.—Dog's Bay, subfossil.—*R. D. Darbishire.*

Cochlicopa lubrica v. viridula, Jeff.

Tipperary S.—Grantstown, one.—*R. Rimmer.* Near Clonmel, one approaching this variety.—*A. H. Delap.*

Carychium minimum, Müll.

Derry.—Coleraine, common.—*L. E. Adams.*

Kerry.—Muckross.—*J. R. Hardy.*

Acme lineata, Drap.

Kerry.—Muckross.—*J. R. Hardy.*

Neritina fluviatilis, L.

King's Co.—River Brusna, Clara, abundant, and nearly all more or less blackly encrusted.—*C. Ashford,* Aug. 1885.

Neritina fluviatilis v. trifasciata, Colb.

King's Co.—Clara.—*C. Ashford.*

Bythinia tentaculata, L.

Down.—Lough Neagh side, several.—*Rev. H. W. Lett,* Aug. 1885.

Tipperary S.—Stream from Rathronan mill-pond, near Clonmel; young specimens very numerous on a caddis-worm's case—*A. H. Delap.*

Valvata piscinalis, Müll.

Tipperary S.—Grantstown, a few, small, June 26, 1885.—*R. Rimmer.*

Planorbis albus, Müll.

Tipperary S.—Grantstown, a few.—*R. Rimmer.*

Planorbis spirorbis, Müll.

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Planorbis vortex, L.

King's Co.—River Brusna.—*C. Ashford.*

Planorbis carinatus, Müll.

King's Co.—River Brusna.—*C. Ashford.*

Down.—Lough Neagh side, a few sent, July, 1885.—*Rev. H. W. Lett.*

Derry.—Coleraine, one sent.—*L. E. Adams.*

Planorbis complanatus, L.

Tipperary S.—Near Clonmel.—*A. H. Delap.* Grantstown, a few, June 26, 1885.—*R. Rimmer.*

King's Co.—River Brusna.—*C. Ashford.*

Planorbis contortus, L.

Tipperary S.—Stream from Rathronan mill-pond, near Clonmel, on a caddis-case, one.—*A. H. Delap.*

Physa fontinalis, L.

Tipperary S.—Near Clonmel.—*A. H. Delap.*

Limnæa glutinosa, Müll.

King's Co.—River Brusna, at Clara.—*C. Ashford.*

Down.—Newry Canal, near Knockbridge.—*C. Ashford.*

Limnæa involuta, Thomps.

Of this interesting form, which, if distinct, is peculiar to Lough Crimcaun, Cromaglaun Mountain, near Killarney, we have had living specimens sent us in 1885, first by Messrs S. A. Stewart and G. A. Holt, on the 14th of June, and again on the 28th of that month, by Mr. W. F. de V. Kane, who observed that it was very scarce and difficult to find. Of these specimens we have made very careful coloured drawings, and Mr. Charles Ashford has dissected one or two of them for us. The odontophores have been placed in the hands of Mr. J. Darker Butterell, for the purpose of being dissected out and mounted.

Pending this and the results of Mr. Ashford's dissections of allied species of Limnæa, we are not yet prepared to decide whether L. involuta is to be regarded as a distinct species, or merely as a form of L. peregra, its nearest ally.

Limnæa peregra, Müll.

Derry.—Coleraine, common.—*L. E. Adams.*

Tipperary S.—Near Clonmel.—*A. H. Delap.* Grantstown, a few, June 26, 1885.—*R. Rimmer.*

Kerry.—Killarney.—*H. Bendall.* Abbey Wood, Valentia, several, May 20, 1871.—*B. Sturges Dodd.* Pools at Killarney, young, 1867.—*J. R. Hardy.*

Limnæa peregra v. ovata, Drap.

Derry.—River Bann, Coleraine, numerous, small, with type.—*L. E. Adams.*

Tipperary S.—Near Clonmel.—*A. H. Delap.* Grantstown, two. —*R. Rimmer.*

Limnæa peregra monst. decollatum, Jeff.

Kerry.—Abbey Wood, Valentia, with type, May 20, 1871.—*B. Sturges Dodd.*

Limnæa peregra v. lacustris, Leach.

Antrim.—Lough Neagh.—*Alder Collection* (from *W. Thompson*).

Down.—Lough Neagh side, common, July, 1885.—*Rev. H. W. Lett.*

Limnæa peregra v. acuta, Jeff.

Clare.—Ballyvaughan, limestone springs at 600 feet altitude.—*T. Rogers;* these specimens had been named by Dr. J. Gwyn Jeffreys.

Limnæa stagnalis, L.

Down.—Lough Neagh side, one sent, July, 1885.—*Rev. H. W. Lett.*

Limnæa palustris, Müll.

Tipperary S.—Near Clonmel.—*A. H. Delap.* Grantstown, one, June 26, 1885.—*R. Rimmer.*

Kerry.—Killarney.—*H. Bendall.*

Waterford.—Near Waterford, Sept. 21, 1883, one.—*J. H. Salter.*

Down.—Lough Neagh side, common, July, 1885.—*Rev. H. W. Lett.*

Limnæa palustris v. tincta, Jeff.

Derry.—Coleraine, common.—*L. E. Adams.*

Limnæa truncatula, Müll.

Derry.—Coleraine, common in a tarn by Port Stewart Bay, April, 1884.—*L. E. Adams.*

Tipperary S.—Near Clonmel.—*A. H. Delap.* Grantstown, one, juv., June 26, 1885.—*R. Rimmer.*

Clare.—Limestone springs, at an altitude of 600 feet above sea-level, Ballyvaughan.—*T. Rogers.*

Galway W.—Connemara.—*Rev. A. Merle Norman.*

Limnæa truncatula v. elegans, Jeff.

Tipperary S.—Near Clonmel, one.—*A. H. Delap.*

Ancylus fluviatilis, Müll.

Down.—Lough Neagh side, one sent, July, 1885.—*Rev. H. W. Lett.*

Tipperary S.—Grantstown, a few.—*R. Rimmer.* Near Clonmel.—*A. H. Delap.*

Sphærium corneum, L.

Tipperary S.—Grantstown.—*R. Rimmer.* Near Clonmel.—*A. H. Delap.*

Sphærium corneum v. flavescens, Macgill.

Down.—Lough Neagh side, a few, July, 1885.—*Rev. H. W. Lett.*

Pisidium fontinale var. pulchella, Jenyns.

Dublin.—Rathfarnham, from Mr. Waller.—*Rev. A. M. Norman's Collection.*

Pisidium pusillum, Gemel.

Tipperary S.—Stream from Rathronan mill-pond, a few on a caddis-case.—*A. H. Delap.*

Anodonta cygnea, L.

Down.—Lough Neagh, very common, but nearly always broken by the sea-gulls and ducks.—*Rev. H. W. Lett*, July 20, 1885.

Unio margaritifer, L.

Wicklow.—Wicklow.—*F. Arnold Lees.*

Waterford.—Waterford.—*R. D. Darbishire.*

Unio margaritifer var. sinuata, Lam.

Tipperary S. }
Waterford. } In the River Suir, dividing these counties, near Clonmel.—*A. H. Delap.*

NOTE IN PRESS.

[*Oct.* 16, 1886.—It may be added that the above Notes extend only to the end of the year 1885, and that numerous specimens have been examined during 1886, which may form material for a supplementary Report.]

XLIII.—REPORT ON THE FLORA OF THE SHORES OF LOUGH REE. By RICHARD M. BARRINGTON, M.A., LL.B., F.L.S., and RICHARD P. VOWELL.

[Read, February 28, 1887.]

LOUGH REE is situated almost in the centre of Ireland. Roscommon forms the west or Connaught shore, Westmeath and Longford the east or Leinster shore. It is, in reality, only an expansion of the River Shannon. The lake proper begins about a mile and a-half from the town of Athlone, and extends almost due north for a distance of seventeen and a-half miles to the village of Lanesborough, varying in width from a little over five and a-half miles to about a mile. Its height over sea-level is 122 feet in summer, and 129 in winter. The area of the entire lake is about 42 square miles, and, for its size, it is one of the shallowest in Ireland. In two places only it reaches a depth of 112 feet; but these are merely holes, the average depth being from 20 to 25 feet. The navigation of the lake is dangerous for yachts, owing to the great number of shallows; and in bad weather an open boat is apt to get swamped, as the waves, though seldom rising to any height, are short and broken. The surrounding district, which forms part of the great central plain of Ireland, is entirely limestone; and the rocks and loose stones on the shore of the lake are all thickly coated with what would seem to be a calcareous sinter precipitated from the waters of the lake. The islands are very numerous, and vary in size from a few yards to about two and a-half miles in circumference. Some of them at the southern end are well wooded, especially that of Hare Island; but the general character of the scenery is cold and bleak. The form of the lake is extremely irregular, more particularly on the Leinster side, where some of the inlets are very large, forming almost separate lakes of considerable extent. These irregularities increase enormously the shore line, which probably measures about 140 miles, although the length of the lake is only 17½ miles. The immediate neighbourhood is mostly low-lying ground, composed of marshy meadows, many of which are under water the greater part of the winter. In a few sheltered bays the shore is richly wooded, and handsome residences, many of which are now deserted and rapidly falling into ruin, are to be met with all round the lake. The River Inny empties itself into Lough Ree at the junction of the counties of Longford and Westmeath, and is the main outlet for the numerous lakes of the latter county. If we except Slieve-Bawn, or Bann, in Roscommon, at a distance of about five miles from Lanesborough, which only rises to the height of 839 feet, there are no mountains visible from any part of the lake. None of the localities given, excepting along the River Inny as far as Bally-

mahon, exceed half a mile from the shore of the lake. All the plants were collected between the lake level, 122 feet and 250 feet, or within a vertical range of 128 feet.

The following is a list of those species observed which do not belong to Watson's British or English types, and are arranged after his "Compendium of the Cybele Britannica":—

Scottish:—
Drosera anglica.
Lamium intermedium.
Potamogeton filiformis.

Scottish-Highland:—
Rubus saxatilis.

Scottish-British:—
Thalictrum minus.
Parnassia palustris.
Gnaphalium diöicum.
Pinguicula vulgaris.
Carex filiformis.

British-Scottish:—
Geum rivale.
Comarum palustre.
Habenaria viridis.
Scirpus cæspitosus.
Eriophorum vaginatum.
Botrychium lunaria.

Intermediate-Scottish:—
Andromeda polifolia.

Highland:—
Galium boreale.
Selaginella selaginoides.
Isoetes lacustris.

British-Highland:—
Lycopodium selago.

Highland-Intermediate:—
None.

English-Germanic:—
Ranunculus circinatus.
Sium latifolium.
Œnanthe phellandrium.
*Nepeta cataria.
Orchis pyramidalis.
Ophrys apifera.

Germanic-English:—
Teucrium scordium.

Germanic:—
Crepis taraxacifolia.

Atlantic-British:—
Hypericum androsæmum.

Atlantic-English:—
Cotyledon umbilicus.

Two visits were made. On the first occasion, from the 24th to the 28th of June, 1885, Athlone was headquarters. A boat was hired, and a man familiar with the lake accompanied us. By this means the islands at the south end, as well as the shore on either side, were examined, returning each night to Athlone. Leaving for the northern end of the lough, and being unable to get lodgings for the night, we selected a sheltered spot on the shore, where a fire was lighted, and

we slept around it in our waterproofs. Had a tent been brought, some time and trouble might have been saved; but in wet weather the specimens dry badly in a tent, as the blotting sheets are continually damp. The method of working was for each of us to land at different points. By this means we avoided going over the same ground, and were enabled to examine a large district each day. During the second visit, from the 5th to the 11th of August, 1886, Mr. Vowell was alone, and very few specimens were then observed which had not been noted in 1885.

The various localities were examined in the following order:—

FIRST VISIT.

1885.

June 24. By boat to Little, Yellow, Carberry, Kid's, Beam, Hare, and Fat Head Islands, and Whinning Point.

,, 25. Shore of Killinure Lough, Temple's Island, Yew Point, and Yellow Island.

,, 26. By road to Ballybay, thence to shore of lake; by boat to Horse, Sedgy, and Whin Islands; shore north of Ballybay to Curry Point.

,, 27. By boat to Cribby Islands; shore at Kilmore Castle and Kilmore Bay; Cornamissoge Point; round Carronure Bay to Rindown Castle; St. John's Wood, Blackbrink Bay and Inchcleraun Island.

,, 28. On Connaught side (Barrington)—Rinanny Point, Clooncah, Cloonmore, Clooneigh River, and Lanesboro'. On Leinster side (Vowell)—Lough Slawn, and from Elfeet Bay, by shore, through Rathcline Wood to Lanesboro'.

,, 29. From Lanesboro', by boat, to Incharmadermot, Clawinch, Black, Inchmore, and Inchturk Islands. Vowell, from Pollagh Point, by Derrymacor Lough to Ballymahon; and Barrington, from Whinningmore Point, by Portleck Castle and Creggan Lough, by road, to Ballymahon.

,, 30. From Ballymahon, by banks of River Inny, to Lough Ree, thence by Doonis Lough, &c., to Killinure Point; road from Coosan Point to Athlone.

SECOND VISIT.

1886.

Aug. 5. Walked from Athlone, by west bank of river, to lake; home by road.

„ 6. Athlone, by east bank of river, to Coosan Point, Hare Island, returning by west shore of Coosan Lough.

„ 7. By road to Curry Hill, returning by shore of lake to Athlone.

„ 8. By boat to Killinure Point; shore of Killinure Lough to Lady Well and Toberclare; Lough Makeegan, Three Pigeons, and by River Inny from Tongbridge to Ballymahon.

„ 9. Ballymahon, by road, to Royal Canal, Drum Lough, Gorteen, Derrymacar Lough; by road through Caltragh to Lough Bannow and Lanesboro'.

„ 10. Lanesboro', by shore, to Clooneigh River, Clooncah, Bracknagh, and Knockcroghery.

„ 11. From Athlone, by boat, to near Clonmacnoise, returning on foot by east bank of Shannon.

All the localities above-mentioned are taken from the One Inch Ordnance Survey Map.

The entire ground over which our examination extended is included in districts 7 and 9 of the "Cybele Hibernica." Considering that none of the localities examined were more than a few feet over the level of the lake, and the flora being therefore a purely lowland one, the district has proved fairly productive, 481 species having been observed.

Omitting doubtful plants, 74 of these are new to district 7, in Leinster, and 39 new to district 9, in Connaught.

The following species, although recorded from every one of the twelve botanical districts in the "Cybele Hibernica," or in its 1872 Supplement, were not observed:—

Hypericum humifusum.

Peplis portula.

Chrysosplenium oppositifolium.—Rather scarce on limestone.

Gnaphalium uliginosum.—This species might be expected.

Symphytum officinale.

Solanum dulcamara.—A local plant, but nevertheless recorded from every district.

Scutellaria galericulata.—Local; but might be expected on the shores of Lough Ree.

Teucrium scorodonia.—This species and the next seems rare in some districts. They were not met with round Lough Erne (see *antea*, p. 16).

Pinguicula lusitanica.

Rumex conglomeratus.—Perhaps overlooked; though it seems less common in Ireland than *R. sanguineus*, *crispus* or *obtusifolius.*

Juncus lamprocarpus.—Perhaps *J. articulatus* has been confounded with this species in some Irish records.

Lychnis githago.

Veronica polita.—Absent from many Irish local lists published since "Cybele Hibernica."

Allium ursinum.—"Less abundant in N. and N. W."—"Cybele Hibernica."

Bromus giganteus (?).

The following species have not been recorded from districts 7 or 9 of "Cybele Hibernica":—

SPECIES NEW TO DISTRICT 7.

Ranunculus circinatus.
,, trichophyllus.
,, pseudo-fluitans.
,, lingua.
Papaver dubium.
,, argemone.
,, hybridum.
Raphanus raphanistrum.
Sinapis alba.
Senebiera coronopus.
Viola canina.
Cerastium glomeratum.
Stellaria glauca.
Medicago lupulina.
* ,, maculata.
Lathyrus palustris.
Orobus tuberosus.
Potentilla procumbens.
Geum intermedium.
Rosa spinosissima.
,, tomentosa.
,, arvensis.
Pyrus aria.
Myriophyllum alterniflorum.
*Apium graveolens.
Bunium flexuosum.
Œnanthe fistulosa.
Daucus carota.
Chærophyllum anthriscus.
Leontodon hispidus.
Sonchus asper.
Hieracium umbellatum.
,, boreale.
*Veronica buxbaumii.
Lycopus europæus.
‡Calamintha acinos.
Stachys ambigua.
Lamium intermedium.
Lithospermum arvense.
Myosotis caespitosa.
Utricularia minor.
Littorella lacustris.
Rumex hydrolapathum.
Populus tremula.
Salix aurita.
,, caprea.
Taxus baccata.
Sparganium simplex.
Lemna trisulca.
Potamogeton perfoliatus.
,, heterophyllus.
,, zizii.
,, pusillus.
,, flabellatus.
,, filiformis.
Habenaria chlorantha.
Cephalanthera ensifolia.
Epipactis latifolia.
,, palustris.
Juncus glaucus.
Cladium mariscus.
Scirpus pauciflorus.
Carex pulicaris.
,, disticha.
,, ovalis.
,, pilulifera.
,, vesicaria.
Digraphis arundinacea.
Alopecurus geniculatus.
Holcus mollis.
Catabrosa aquatica.
Bromus sterilis.
Equisetum palustre.
Chara tomentosa.

Species New to District 9.

Ranunculus circinatus.
,, pseudo-fluitans.
Erysimum cheiranthoides.
Polygala depressa.
Lychnis vespertina.
Arenaria serpyllifolia.
Sagina apetala.
Medicago lupulina.
Lathyrus palustris.
Prunus avium.
Rosa arvensis.
Myriophyllum spicatum.
Pimpinella saxifraga.
Sium latifolium.
,, angustifolium.
Scandix pecten-veneris.
Galium uliginosum.
Valerianella dentata.
Carduus tenuiflorus.
Carlina vulgaris.
Crepis taraxacifolia.
Veronica hederæfolia.
* ,, buxbaumii.
*Linaria minor.
Rumex hydrolapathum.
Euphorbia exigua.
Potamogeton zizii.
,, flabellatus.
,, filiformis.
Hydrocharis morsus-ranæ.
Elodea canadensis.
Scirpus acicularis.
Carex paniculata.
,, pseudo-cyperus.
Glyceria aquatica.
Sclerochloa rigida.
Isoetes lacustris.
Equisetum maximum.
Chara tomentosa.

Taking the species in order, the rarest and most interesting discovered were, *Papaver argemone* and *hybridum*, thus extending the range considerably to the west, where this genus is rare. A form of *Viola canina* grew in the bogs near Clonmacnoise, which bears some resemblance to *stagnina*, but was not that variety. *Stellaria glauca* was plentiful. *Rhamnus catharticus* was very common, but *R. frangula* was not seen. *Lathyrus palustris* was specially abundant in a large meadow on the left bank of the Inny, going towards Lough Ree, forming a considerable portion of the vegetation. *Rubus saxatilis*, at Yew Point and some other places, assumed puzzling forms. *Myriophyllum verticillatum* was gathered near Ballybay. *Cicuta virosa* occurred near Lanesborough. *Sium angustifolium* was less frequent than *S. latifolium* (this was also the case at Lough Erne), though in Great Britain the reverse is true. *Galium uliginosum* was noticed on the west shore. It dries green, and is totally different from any form of *G. palustre*. When the "Cybele Hibernica" was written, doubts were entertained as to whether it was really an Irish plant, but it has since been found in Westmeath. *Crepis taraxacifolia*, a species common about Dublin and Kingstown, where it is of recent introduction, and is extending on the east coast, was gathered near Athlone, probably introduced by means of the railway, along which other species have also spread westward. In America European "colonists" extend with wonderful rapidity along the western railways. *Hieracium umbellatum*, a rare species, and inte-

resting from its also occurring on similar small islands in the middle of Lough Erne. *Calamintha acinos*, hitherto only found in Dublin and Wicklow. *Teucrium scordium* occurs in abundance. There is an old record about it, *fide* I. B. (Isaac Butler) Annot. in Threlkeld. *Rumex hydrolapathum* was noticed on both the Leinster and Connaught shores, and *Potamogeton rufescens* near Ballykeeran. A curious *Potamogeton* growing in the Inny was submitted to Mr. Bennett of Croydon, an authority on this difficult and very variable genus, and he has referred it to *P. fluitans*, Roth (?). Ripe fruit, however, must be procured before this species can be added to the Irish flora with certainty. *P. zizii*, a species recently added to the Irish list, was abundant. *Potamogeton filiformis*, which belongs to Watson's Scottish type, and whose range has been lately extended in Ireland, was frequent. *Habenaria chlorantha* could only be found in one spot, whereas *H. bifolia*, which is far less common in Ireland, was plentiful. *Cephalanthera ensifolia*, a very rare orchid, grew on the shore of Hare Island in tolerable plenty. *Cladium mariscus* was frequent, and *Scirpus acicularis* was seen on the west side. *Carex teretiuscula*, a local plant, grew in many places. On Temple Island a remarkable *Carex* was noticed; but it may be only a form of *C. stricta*. *Chara tomentosa*, so very rare in England, but which the late Dr. Moore found in Lough Derg and in Belvidere Lake, grew plentifully in a few places. A *Chara* without fruit may prove to be *C. strigosa*, and if so, a species new to Ireland.

Plants certainly introduced are marked (*); those probably introduced (†); and species possibly introduced (‡).

We are indebted to Mr. Arthur Bennett for his assistance in examining the Potamogetons, and all the Characeæ have been kindly named by Mr. Groves.

N.B.—Those species already recorded in the "Cybele Hibernica," or in its Supplement, published in 1872, from *all* the twelve botanical districts into which Ireland has been subdivided in that standard work, are omitted. These common species number 270, and all were obtained but the 15 enumerated already. The total number observed was 481.

[LIST OF SPECIES.

LIST OF SPECIES.*

Thalictrum minus, Linn.—Hare Island, &c. Sparingly distributed on the margins of the lake.

,, *flavum*, Linn.—Hare Island, Temple Island. Frequent.

Ranunculus circinatus, Sibth.—Drain by banks of Inny, below Ballymahon, and in Royal Canal.

,, *heterophyllus*, Fries.—St. Martin's Well, Inchcleraun, &c.

,, *pseudo-fluitans*, Syme.—River Inny, &c. The form with floating leaves, *penicillatus* of Dumortier, only observed.

,, *trichophyllus*, Chaix.—Drain near Ballykeeran, with *Potamogeton rufescens*.

,, *hederaceus*, Linn.—Rare. Between Clooneigh river and Lanesborough.

,, *peltatus*, Fries?—A form growing in deep water near Athlone, with the middle lobe of the floating leaves entire, and conical in outline, has been doubtfully referred to this variety.

,, *sceleratus*, Linn.—Near Athlone.

,, *lingua*, Linn.—In suitable places all round the lake.

[,, *auricomus*, Linn.—Apparently wanting; but, as it flowers early, it may have been overlooked.]

‡*Aquilegia vulgaris*, Linn.—Two or three plants near Coosan Point.

Nuphar lutea is more abundant than *Nympœa alba*.

**Papaver rhœas*, Linn.—Common on Leinster side, but not observed on Connaught shore.

* ,, *dubium*, Linn.—Cultivated ground at Elfeet Bay, &c. Not uncommon.

* ,, *argemone*, Linn.—Railway near Kiltoom, and one or two other places at both sides of lake. Sparingly.

* ,, *hybridum*, Linn.—Seen only in a corn-field at Elfeet Bay.

**Chelidonium majus*, Linn.—Roadside near Ladywell. One or two plants.

Fumaria capreolata, Linn.—Cultivated ground.

,, *officinalis*, Linn.—Cultivated ground.

†*Raphanus raphanistrum*, Linn.—One or two specimens. Near Ladywell.

Sinapis alba, Linn.—Near Athlone, &c.

Sisymbrium officinale, Scop.—Common.

**Erysimum cheiranthoides*, Linn.—Hudson's Bay. Cultivated ground.

**Cheiranthus cheiri*, Linn.—Old toll-gate, Athlone.

Arabis hirsuta, Linn.—Sand-pits near Kiltoom.

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* 270 common species are omitted. See previous page.

Nasturtium palustre, D. C.—Sparingly. West shore, near Clooneigh river.

„ *amphibium*, Brown.—Frequent in drains all around the lake.

Draba verna, Linn.—Near Ballymahon.

†*Senebiera coronopus*, Poir.—Roadside near Lanesborough, Athlone, &c.

Viola palustris, Linn.—In bog near Kiltoom, &c.

„ *tricolor*, Syme.—Yew Point, Hudson's Bay.

„ *arvensis*, Murr.—Cultivated ground.

„ *canina*, Auct.—Boggy ground on the bank of the Shannon near Clonmacnoise. In isolated, erect, branching tufts.

Drosera anglica, Huds.—Bog at Ballybay, and most of the other bogs on each side of lake. More abundant than *Drosera rotundifolia*. *D. intermedia* not seen.

Polygala depressa, Wender.—Yew Point.

**Saponaria officinalis*, Linn.—Athlone.

Silene inflata, Sm.—Frequent.

„ „ var. *puberula*.—Kilmore Castle.

Lychnis vespertina, Sibth.—Yew Point and Hudson's Bay.

[„ *diurna*, Sibth.—Not seen.]

[„ *githago*, Lam.—Not seen.]

Cerastium glomeratum, Thuil.—Common.

„ *triviale*, Link.—Common.

Stellaria holostea, Linn.—St. John's Wood, &c. Scarce.

„ *glauca*, With.—In a drain near Kiltoom, both sides of lake, near Lanesborough, and along River Inny, &c. Frequent.

Arenaria trinervis, Linn.—St. John's Wood. Rare.

„ *serpyllifolia*, Linn.—Coosan Point and other places.

„ „ var. *leptoclados*.—Railway bank, Athlone.

Sagina apetala, Linn.—Frequent.

„ *nodosa*, Meyer.—Yew Point.

**Hypericum pulchrum*, Linn.—Hare Island, &c. Frequent.

[**Malva sylvestris*, Linn.—Though recorded from the twelve districts of "Cybele Hibernica," only two plants were seen near St. John's Castle.]

† *Geranium pyrenaicum*, Linn.—Rare. Ballymahon churchyard.

„ *dissectum*, Linn.—Only seen in one or two places; scarce.

„ *lucidum*, Linn.—Road near Cashel Lodge and Inchcleraun Island.

Ilex aquifolium, Linn.—On many of the islands.

Euonymus europæus, Linn.—On many of the islands and on shore of lake.

Rhamnus catharticus, Linn.—Plentiful.

Ononis arvensis, Aust.—Only seen in a field at Ladywell.

Anthyllis vulneraria, Linn.—Common on margins of lake.

Medicago lupulina, Linn.—Common.

* „ *maculata*, Sibth.—A single plant not in flower was gathered.

Trifolium procumbens, Linn.—Inchcleraun, near Athlone.
[*Lotus major*, Scop.—Not seen.]
Lathyrus palustris, Linn.—Temple Island, near Lanesborough; banks of River Inny, and several places on west side of Shannon, near Athlone, &c.
Orobus tuberosus, Linn.—Scarce, only a few plants observed.
Prunus avium, Linn.—Near Athlone.
Agrimonia eupatoria, Linn.—Frequent.
Poterium sanguisorba, Linn.—Rare. Only seen on shore of Rinardo Bay.
Potentilla procumbens, Sibth.—In plantation near Derrynagease Lodge.
Rubus idæus, Linn.—Hare Island, &c.
„ *saxatilis*, Linn.—Shore at Yew Point and elsewhere.

Other *Rubi* were collected, but have not yet been identified, as there is much want of unanimity among botanists concerning this difficult and variable genus.

Geum intermedium, Ehrh.—Rare. Rathcline Wood, near Lanesborough.
Rosa spinosissima, Linn.—Common.
„ *rubiginosa*, Linn (?).—Specimen gathered at Coosan Point has been doubtfully referred to this species.
„ *tomentosa*, Sm.—Frequent.
„ *arvensis*, Huds.—Not common. St. John's Wood.
Pyrus aria, Hooker.—Noticed on most of the islands, and St. John's Wood.
„ *aucuparia*, Gaert.—Hare Island.
„ *malus*, Linn.—West side of Yew Point. Not common.
Epilobium hirsutum, Linn.—Common.
„ *palustre*, Linn.—Occurs frequently.
Myriophyllum spicatum, Linn.—River Inny, &c.
„ *alterniflorum*, D. C.—Near Kiltoom, &c.
„ *verticillatum*, Linn. — Rare. In a drain running through a small plantation at Ballybay.
**Ribes grossularia*, Linn.—Occurs in two places on margin of lake near Coosan Point.
Sedum acre, Linn.—Yew Point, on sand.
**Sempervivum tectorum*, Linn.—Old walls (ruins) near Elfeet Bay.
Saxifraga tridactylites, Linn.—Athlone, Yew Point.
Parnassia palustris, Linn.—Very common.
Cicuta virosa, Linn.—On both sides of the lake south of Lanesborough. Not seen near Athlone.
**Apium graveolens*, Linn.—One or two plants, evidently an escape.
Helosciadium inundatum, Koch.—Bog near Kiltoom.
Ægopodium podagraria, Linn, Near Ballymahon.
Bunium flexuosum, With.—Frequent.

Pimpinella saxifraga, Linn.—Common.
Sium latifolium, Linn.—In many places.
„ *angustifolium*, Linn.—Rather scarce, more so than preceding species.
Œnanthe phellandrium, Linn.—Common.
„ *fistulosa*, Linn.—Near Lanesborough, and by River Inny. Common.
[„ *crocata*, Linn.—Not seen.]
Æthusa cynapium, Linn.—Cultivated ground.
Daucus carota, Linn.—Common alongside the shore of lake.
Chaerophyllum anthriscus, Linn.—Lanesborough, Coosan Point, &c.
Scandix pecten-veneris, Linn.—Frequent in cultivated ground. Not a common plant in Ireland.
Galium boreale, Linn.—Growing plentifully among the loose stones on the islands and on the shore of the lake.
„ *palustre*, Linn.—Common.
„ „ var. *witheringii*.—A very uncertain variety. It was quite as common as *G. palustre*, in fact all the specimens dried have more or less bristles on the stem and leaves, and there would appear to be no constant relation between the bristles and the shape of the leaves, or the habit of the plant.
„ *uliginosum*, Linn.—Peat bog between Ballybay and Curry-point. This species, especially when dried, has a very different appearance from any forms of *G. palustre* we have seen. Known hitherto only from Kildare and Westmeath.
Valerianella olitoria, Moench.—Cultivated ground, Elfeet Bay.
„ *dentata*, Koch.—Common in cultivated ground.
Scabiosa arvensis, Linn.—Not uncommon.
Carduus tenuiflorus, Curt.—Yew Point.
Carlina vulgaris, Linn.—Generally distributed.
Arctium intermedium, Lange.—Near Athlone.
Tanacetum vulgare, Linn.—West side, below Lanesborough.
[*Gnaphalium uliginosum*, Linn.—Apparently wanting.]
„ *dioicum*, Linn.—Frequent.
Bidens cernua, Linn.—Banks of Shannon, below Athlone, and shore of lake.
Leontodon hirtus, Linn.—Not common.
„ *hispidus*, Linn.—Rare. Dry fields near Creggan Lough.
Sonchus asper, Hoffm.—Only a few plants were observed.
**Crepis taraxacifolia*, Thuil.—Near Athlone, and one or two other places.
Hieracium umbellatum, Linn.—Hare Island. Specimens not in flower, but identical with plants collected on an island in Lough Erne. (See *antea*, p. 14.)

Hieracium boreale, Fries.—Coosan Point.

Campanula rotundifolia, Linn.—Common everywhere.

Vaccinium oxycoccos, Linn.—Only seen in a bog near Derrymacar Lough.

Andromeda polifolia, Linn.—In a bog at Ballybay, and many other places.

Chlora perfoliata, Linn.—Rather scarce.

Gentiana amarella, Linn.—Only seen on the east bank of the Shannon, below the bridge at Athlone.

Verbascum thapsus, Linn.—Yew Point. Not common.

**Antirrhinum majus*, Linn.—Naturalized on the walls of Kilmore Castle.

**Linaria minor*, Desf.—Railway near Kiltoom.

* ,, *cymbalaria*, Mill.—Naturalized on Carbery Island.

Veronica hederæfolia, Linn.—Shore of Killinure Lough, &c.

[,, *polita*, Fries.—This species is not marked in our catalogues, and it has been omitted from most of the local lists on Irish Botany published since the "Cybele Hibernica," in which it is recorded from every district and marked "common." Perhaps it has been confounded with *V. agrestis*, to which it is closely allied.]

* ,, *buxbaumii*, Ten.—Cultivated ground. This species is now widely distributed over Ireland.

,, *montana*, Linn.—Hare Island, &c.

,, *scutellata*, Linn.—Common.

Lycopus europaeus, Linn.—Not common.

Mentha piperita, Huds.—A single specimen gathered is referred to this species with some doubt—as the pedicles and calyx are hairy—but the leaves are nearly glabrous, and the corolla is glabrous within and without. If it be *M. piperita* it is, perhaps, the form *vulgaris*, Sole.

Origanum vulgare, Linn.—Near St. Martin's Well, and roadside near Ballymahon and Lanesborough.

**Calamintha acinos*, Clairv.—Only near St. Martin's Well, opposite island of Inchinagh.

**Nepeta cataria*, Linn.—Bracknagh, by roadside.

Stachys ambigua, Sm.—Only seen near Ballymahon.

Lamium intermedium, Fries.—Lanesborough.

,, *album*, Linn.—Roadside near Ballybay, Athlone, &c.

Teucrium scordium, Linn.—Growing in abundance around the islands and on the shore of the lake at the southern end, but not so plentiful at the northern end, from which it has been recorded. *Fide* I. B. (Isaac Butler) Annot. in Threlkeld. Below the bridge of Athlone, among the long grass on the banks of the river.

[*Teucrium scorodonia*, Linn.—Not seen here nor at Lough Erne by Barrington; possibly a local plant in the west of Ireland.]

Lithospermum arvense, Linn.—Cultivated ground near Lough Slawen, and on Island of Clawinch and Black Islands.

Myosotis cæspitosa, Schultz.—More plentiful than any other of the genus.

Utricularia vulgaris, Linn.—Common in drains all round lake.

,, *minor*, Linn.—Near Derrymacar Lough, at Creggan Lough and Coosan Lough.

Primula officinalis, Linn.—Only seen on Hare Island.

Lysimachia vulgaris, Linn.—Common.

Samolus valerandi, Linn.—Common.

Littorella lacustris, Linn.—Abundant on the shore of the lake.

Chenopodium album, Linn.—Common.

,, *bonus-henricus*, Linn.—Near Ballymahon.

[*Atriplex angustifolia*, Sm.—No doubt overlooked.]

Rumex hydrolapathum, Huds.—By the River Inny, Derrymacar, &c., on east shore; Clooneigh River, west shore.

Polygonum amphibium, var. *terrestre*, Linn.—This variety was more plentiful than the ordinary form.

**Euphorbia cyparissias*, Linn.—In a plantation near Derrynagease Point. Evidently introduced.

,, *exigua*, Linn—Cultivated ground. Common.

[,, *hiberna*, Linn.—Recorded from Slieve-Bann (Slieve Baun), 839 feet, in Roscommon, 5 miles from the head of Lough Ree, by Dr. Patrick Browne. Locality not visited by us.]

Populus tremula, Linn.—Frequent. Perhaps native.

,, *alba*, Linn.—Planted.

Salix aurita, Linn.

,, *caprea*, Linn.

,, *repens*, Linn.

**Taxus baccata*, Linn.—A venerable tree on Inchcleraun Island.

Typha latifolia, Linn.—Rather scarce.

Sparganium simplex, Huds.—In Shannon near Athlone, &c.

,, *minimum*, Fries.—Near Coosan Lough in a bog-hole, &c.

Lemna trisulca, Linn.—Ballybay, and near Doonis Lough.

,, *polyrhiza*, Linn.—In a drain near Doonis Lough.

Potamogeton polygonifolius, Pour.—Common.

,, *fluitans*, Roth., var. *rivularis*, Lange?—A species growing in abundance in the River Inny, below Ballymahon, has thus been named by Mr. A. Bennett. Unfortunately, no ripe fruit was obtained, and this interesting form cannot with certainty be added to the Irish flora until more perfect specimens are gathered. In Symes' *English Botany*, *P. fluitans* is referred to as an excluded species, but it has recently been recorded from one locality in England.

Potamogeton rufescens, Schrad.—Only in a drain near Ballykeeran, with *Ranunculus trichophyllus*.

„ *perfoliatus*, Linn.—Common.

„ *heterophyllus*, Schrad.—Common.

„ *zizii*, Roth.—Plentiful. In the lake a form closely approaching *P. lucens* occurred, but was referred to this species by Mr. Bennett. In the River Inny a very different form was gathered, with willow-shaped leaves, about half an inch broad, and three or four inches long, which has also been referred to this species by the same authority.

„ *lucens*, Linn.—Common. Difficult to distinguish from specimens named *P. zizii* by Mr. Bennett.

„ *pusillus*, Linn.—Frequent in drains.

„ *pectinatus*, Linn.—A long form resembling *P. flabellatus* was gathered in the Inny.

„ *flabellatus*, Bab.—In the Shannon near Athlone.

„ *filiformis*, Nolte.—Frequent. A very long and slender form, with the leaves distant, and peduncles 8 to 10 inches long, occurs in deep water. It exactly resembles Barrington's Lough Erne plant. The shorter variety, figured in Symes' *English Botany* was also gathered.

Zannichellia palustris, Linn.—In a drain near Kiltoom.

Sagittaria sagittifolia, Linn.—River Inny, and many other localities.

Hydrocharis morsus-ranæ, Linn.—Doonis Lough, Coosan Lough, and Rinanny Point.

**Elodea canadensis*, Mich.—Shannon at Athlone, River Inny, &c. Said to be disappearing.

Orchis incarnata, Linn.—Two forms occurred, one with deep claret-coloured flowers and broad leaves, the other with lilac flowers, usually taller, and with narrower leaves. The former was perhaps *latifolia*. As to Symes' plate of *Orchis incarnata*, "Linn.," in his *English Botany*, see Paper read by C. B. Clarke, *Journal*, Linnæan Society, vol. xix., p. 206.

Gymnadenia conopsea, Brown.—Athlone and one or two other places; but scarce.

Habenaria viridis, Brown.—Apparently scarce.

„ *bifolia*, Bab. Man.—Abundant in many places.

„ *chlorantha*, Bab.—Only observed in one locality on the east side of Rinardo Bay.

Ophrys apifera, Huds.—Generally distributed all round the lake.

Epipactis latifolia, Auct.—Hare Island.

„ *palustris*, Crantz.—One or two places round Killinure Lough, and abundant in meadows near Athlone.

Cephalanthera ensifolia, Rich.—Common on the west shore of Hare Island. A few plants on Crow Island.

Juncus glaucus, Sibth.—Frequent.

Cladium mariscus, Brown.—Near Ballykeeran on Killinure Bay, bog between lake and Kiltoom, Derrymacar Lough and Doonis and Creggan Loughs, &c.

Rhynchospora alba, Vahl.—Derrymacar bog, and one or two other places.

Scirpus acicularis, Linn.—Only on west side, near Clooneigh River.

,, *pauciflorus*, Lightf.—Common.

,, *fluitans*, Linn.—In a bog near Kiltoom.

Eriophorum vaginatum, Linn.—Rather scarce.

Carex pulicaris, Linn.—Common.

,, *disticha*, Huds.—Abundant on banks of Inny, &c.

,, *teretiuscula*, Good.—Derrymacar, near Kiltoom, &c.

,, *paniculata*, Linn.—Noticed in most of the swamps on east side S. of Lanesborough, also on west side, near Clooneigh River. A depauperated form, approaching *C. paradoxa*, most frequent.

,, *remota*, Linn.—Roadside, near Lanesborough.

,, *ovalis*, Good.—Frequent.

,, *stricta*, Good.—Common. On Temple Island, inner lough, exceptionally large specimens were observed here.

,, *stricta*, Good, var. (?)—A *Carex* gathered on Temple Island, growing in large tufts on the shore, is doubtfully referred to this species. The final spikelet is solitary, slender, and somewhat pendulous, and its lower half tapering and gradually depauperated. The lower bract falls considerably short at the apex of the terminal male spikelet. This *Carex* has been submitted to Mr. A. Bennett, who is unable to identify it with certainty, suggesting *C. aquatilis epigyis*, except for the nerves on the fruit, which are very distinct.

,, *filiformis*, Linn.—Shore of inner lough, Temple Island, plentiful, and Rathcline.

,, *pilulifera*, Linn.—Frequent in suitable places.

,, *binervis*, Sm.—Frequent in suitable places.

,, *hornschuchiana*, Hoppe.—Common. The variety *xanthocarpa, Degl*, was gathered at Rathcline.

,, *pseudo-cyperus*, Linn.—Only near Ballybay.

,, *riparia*, Curtis.—Drain near Ballymahon.

,, *vesicaria*, Linn.—Near Athlone.

Digraphis arundinacea, Trin.—Common.

Alopecurus geniculatus, Linn.—Common.

,, *pratensis*, Linn.—Frequent.

Phleum pratense, Linn.—Frequent.

Holcus mollis, Linn.—Not uncommon.

Avena flavescens.—Frequent.

Kœleria cristata, Pers.—Yew Point, near Rindown Castle.
Melica uniflora, Retg.—In suitable places.
Catabrosa aquatica, Beauv.—Frequent.
Glyceria aquatica, Sm.—By Shannon, at Athlone, and Royal Canal.
Sclerochloa rigida, Link.—Near Ballymahon.
Bromus sterilis, Linn.
Filices.—None but the common species were observed.
Lycopodium selago, Linn.—Frequent in the bogs.
Selaginella selaginoides, Grey.—Not uncommon.
Isoetes lacustris, Linn.—Kilmore Bay.
Equisetum maximum, Linn.—Near Lanesborough.
,, *palustre*, Linn.—Common.
Chara tomentosa, Linn.—Plentiful by the shore near Rindown Castle, and elsewhere on the west side. Near Coosan Lough, east side.
,, *hispida*, Lin.—Var *rudis*.
,, *vulgaris*, L.
,, ——.—A plant without fruit, and which is stated by Mr. James Groves to "closely resemble" *C. strigosa*, was gathered. This species would be new to Ireland.

XLIV.—ON THE DISTRIBUTION OF TEMPERATURE OVER GREAT BRITAIN AND IRELAND. By HENRY HENNESSY, F.R.S., Professor of Applied Mathematics in the Royal College of Science for Ireland. (With a Map.)

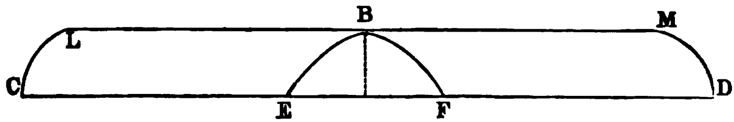
[Read, June 28, 1886.]

IN islands surrounded by waters whose temperature is in excess of the temperature of the air, I have long since shown that the distribution of temperature must be represented by isothermal lines, similar in outline to the coasts of the islands, and with the centres of the isothermals transported in the direction of the nearest pole of the earth.[1] This result has never been controverted, but it has been confirmed so completely by observations as to become an established fact of climatology. But as the distribution of temperature may be represented either from the actual facts collected or by the reduction of the temperatures to their supposed values at the sea level, it may be useful to make some remarks on the variation of temperature with height in the atmosphere, and on the utility of the so-called corrected temperatures obtained by reduction to the sea level.

If the air were perfectly still, the temperature of any molecule would depend—(1) upon the density of the strata in which it is; (2) upon the heat which it absorbs from the solar rays by which it is traversed; (3) upon that which it absorbs from terrestrial radiation, and upon what it loses by radiation into space. The most important of these, (1), has been usually taken into consideration by physical writers, especially in treatises of the question of ascertainment of heights by the barometer. But the air is never perfectly still; even in a calm day, frequent and rapid currents promote interchanges of temperature between its several strata. Close to the earth's surface the energy and numbers of such small air currents become so great as to cause a rapid variation of temperature; and it follows that the temperature of a molecule of air is thus a function of its distance from the nearest surface capable of imparting heat to it, or of absorbing heat from it. It is also a function of the extent, form, and physical character of such a surface. To illustrate these points, let us suppose the line C D to represent a flat plain nearly at the level of the sea. An observer stationed in a balloon at B, 1000 feet above the plain, would find the temperature of the air cooled by contact with its surface. If a mountain with a much broader base be superimposed, but

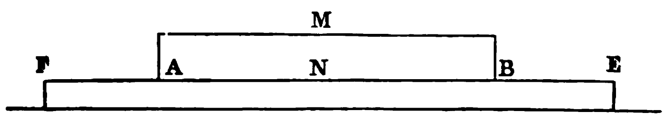
[1] The late Dr. Lloyd, Provost, T.C.D., long since acknowledged this result. "The actual isothermal lines of Ireland are inflected in passing from the sea to the land, and must even, in part of the island—as Mr. Hennessy has pointed out—take the form of *closed curves*, dependent on the position of the places traversed with respect to the coast-line."—Lecture on "The Climate of Ireland and Currents of the Atlantic": Dublin, 1865. See Atlantis, vol. i., p. 396; Philosophical Magazine, October, 1858; and Proceedings of the Royal Society, vol. ix., p. 324.

with the same height, this effect will be still greater. If the whole plain be elevated up to B, or a table-land of great extent, C L M D, be superimposed, it is evident that the contact of contiguous atmospheric exchanging currents will still more affect the temperature at



B. Hence we must conclude that the temperature, in ascending elevated ground, cannot follow a law independently of the nature of the ground. At night the temperature should be much lower on elevated ground than on low ground, or, in other words, the thermometrical range should be greatly increased on mountains and high grounds. This may also be thus illustrated:

Suppose an elevated plain C D, also F E, by 1000 feet, a thermometer at M will be influenced by the causes specified in connexion with general temperature of the entire strata of air 1000 feet at F E. But C D absorbs heat: it heats the strata in contact with and elevates



the thermometer. Let this be supposed to retain its place, and C D to sink down until it reaches the point A B. A thermometer at N would now indicate the temperature due to all the causes above specified, together with the heating of the strata by the causes referred to, while that at M would be deprived of the latter influences.

General Baeyer remarks, from observations made on the Brocken, and at Kupferkule, below it, that the variation of temperature between these strata was not uniform: in fact a stratum of air intermediate between both was warmer than either. This occurs from ascending warm currents by day which retain much of their heat in consequence of their small conductivity. [Convexion is less active as the cooler strata above have also a small amount of density; and thus when the warmed air ascends to a certain height it is less liable to be lowered in temperature by the descent of cooler particles through it from above.] During the night the soil radiates its heat so rapidly as to sensibly cool the air immediately above it; consequently the greatest differences of temperature between the intermediate stratum and the ground stratum must occur about dawn. When a mountain top ascends abruptly, the warm stratum it radiates also into space, and the air shows a low temperature all about it. The variation of temperature from the intermediate stratum upwards was greater than from the same stratum downwards. Similar variations of temperature have been noticed by other observers. Arago quotes the results of

M. Guerin in ascending to Ventoux, who found a diminution in summer 1° C. for 156 metres of ascent, while in contact this was for 195 metres. The comparison of the torrid with the temperate zone is fallacious, as the results from the torrid zone were chiefly obtained from the surfaces of high and extensive table-lands, while in Europe they were made on more isolated and rapidly ascending ridges.

Forbes gives numbers different from Arago; and so does Kæmtz. According to Forbes, there is a greater decrement in equatorial than in temperate latitudes. He repeats the same remark at page 58 of the same volume, Reports of the British Association for 1840. He also quotes Biot in the Comptes rendus in support of the views put forward.

From all the foregoing facts it may be concluded that the variation of temperature with height is far from being correctly represented by those who assume, for every part of the surface of islands and continents, a decrease of one degree Fahrenheit for every 300 feet of altitude. So-called corrections of temperature made on this assumption might be more truly called systematic interpolations of errors. But, moreover, even if this arbitrary reduction were correct, it is not justifiable; for the object of temperature maps is to make manifest the connexion between distribution of heat in the atmosphere close to the ground with other phenomena, such as moisture and wind, or with the distribution of plants and animals. All of these are influenced by the actual temperatures, and not by the so-called corrected temperatures for height. A map of the flora of a mountainous country would, with the system of so-called corrections for height above the sea, present the anomalous appearance of groups of Alpine or Arctic plants touching the same isothermal lines as plants of temperate regions.

The temperature maps of a continental country which, in some respects, is circumstanced most nearly like the British Isles, namely, Scandinavia, are instructive on this point. They have been drawn by Professor Mohn of Christiania, and I have before me those which accompany the beautiful work of Dr. Schübeler on the "Flora and Plant Culture of Norway."[1] They are constructed without the misleading "correction" in height, which, in this case, would involve the most absurd consequences as to the distribution of plants in relation to temperature. As in the British Islands, some of the isothermal lines are closed curves, and most of the others resemble the general outline of the Scandinavian peninsula. Among British botanists the correct correlations of temperature and plant distribution were long since distinctly maintained at the International Botanical Congress in London, when the late Dr. D. Moore and Mr. A. G. More exhibited a map based on the distribution of temperature I had laid down in my first memoir in the Atlantis.[2]

In the Journal of the Scottish Meteorological Society, Mr. Buchan has collected an important series of facts as to the temperature of

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[1] Norge's Vaextrige, 1st Bind. Christiania, 1885.

[2] "On the Climate, Flora, and Crops of Ireland: Report of International Horticultural Exhibition and Botanical Congress," p. 165. London, 1866.

Great Britain and Ireland; but the maps constructed from these facts are much less valuable owing to the arbitrary deformation of the facts by the so-called correction for height. I have grouped the temperature results with others which are published in some of my Papers, and these being the true representations of the actual state of things, serve better to construct the temperature map which accompanies this Paper.

Mr. Buchan would have done well if he had profited by the suggestion of his correspondent, Dr. von Wojeike, who wrote: "I believe the best attempt to trace the isotherms for a great part of the globe was made by Petermann in his Mitheilungen, vol. VI., because he does give the actual facts, and, what is extremely important, for great continents *he does not reduce to the sea level.*"

That the isothermals of the islands of Great Britain and Ireland must conform to the law I have enunciated is certain from the acknowledged excess of temperature of the seas bathing their coasts. Mr. Whitley has made a series of observations of the temperature of the sea off Cornwall, which prove that the sea is from 2° to 3° warmer off the south-west coast of England than the air. From Mr. Buchan's Papers it seems that the mean sea temperature surrounding the north and north-east coasts of Scotland is 48°, and at the Orkney, Shetland, and Western Isles, the temperature of the sea exceeds that of the air by 3°. In my Report on the Temperature of the Sea on the Coasts of Great Britain and Ireland, appended to the Report of the Royal Commission on Oyster Culture, I have given results of observations which show that the sea temperature around the coast of Ireland is in general superior to that of the air, and that the same superiority holds good for the greater part of the coasts of England and Scotland. On the east coast of Ireland, in Dublin Bay, on a day in mid-winter, with the ground still slightly frozen, I have plunged a thermometer into the sea water, and the mercury immediately rose to 41°, while a thermometer hanging freely in the air stood at 36°. At other seasons of the year the difference would be less, and in the months of greatest sunshine—May, June, and July—the result might be slightly reversed, as appears from facts I have published in the Report above quoted.[1]

The temperature map constructed from the more extended observations recorded in the foregoing Tables shows that the isothermal lines of Great Britain and Ireland conform to the law cited at the commencement of this Paper, and the influence of distance from the sea is manifest in consulting the column of distances and comparing them with latitudes and temperatures. As long as the shores of these islands continue to be washed by the heat-bearing currents of the Atlantic, it may be safely predicted that the distribution of temperature will be represented by isothermal lines possessing the same general character as those which have been laid down by me in this and former Essays on the subject.

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[1] See Appendix E to "Report on Oyster Culture," p. 68. 1870.

GREAT BRITAIN AND SMALL ISLANDS.

STATION.	Mean Temperature.	Distance from Sea in miles.	Latitude.		Longitude.		Height above Sea in feet.
	Fahrenheit.		°	′	°	′	
Helston, ...	53°·5	1	50	7	5	12	106
Culenik, ...	53 ·0	0	50	0	5	10	—
Truro, ...	52 ·1	7	50	17	5	3	43
Sidmouth, ...	52 ·1	0	50	41	3	13	—
Plymouth, ...	52 ·0	0	50	22	4	7	—
Ventnor (Wight), . .	51 ·9	0	50	35	1	12	153
Penzance, ...	51 ·8	0	50	7	5	33	—
Barnstaple, ...	51 ·6	8	50	05	4	3	100
Falmouth, ...	51 ·6	2	50	9	5	6	—
Devonport, ...	51 ·4	0	50	17	4	5	35
Exeter, ...	51 ·4	10	50	44	3	31	164
Osborne (Wight), . .	51 ·2	1	50	45	1	14	172
Bournemouth, . . .	51 ·2	0	51	44	1	55	100
Swansea, ...	51 ·2	0	51	36	3	53	—
Torquay, ...	51 ·1	0	50	27	3	32	150
Liverpool, ...	51 ·0	0	53	25	2	59	37
Ryde (Wight), . . .	50 ·7	2	50	43	1	11	—
Eastbourne, . . .	50 ·7	0	50	44	0	17 E.	12
Greenwich, ...	50 ·6	33	51	28	0	0	159
Worthing, ...	50 ·6	0	51	47	0	22 W.	34
Maidstone, ...	50 ·6	16	51	6	0	32 E.	230
Llandudno, ...	50 ·5	0	52	20	3	50 W.	100
Teignmouth, . . .	50 ·5	0	50	33	3	30	—
Lewisham, ...	50 ·5	34	50	27	0	1 W.	60

STATION.	Mean Temperature.	Distance from Sea in miles.	Latitude.		Longitude.		Height above Sea in feet.
	Fahrenheit.		°	′	°	′	
Gloucester, ...	50°·3	22	51	58	2	14 W.	100
Clifton, ...	50 ·2	7	51	28	2	36	228
Bath, ...	50 ·2	16	51	24	2	20	86
Shorncliff, ...	50 ·2	0	51	5	1	10 E.	220
Colchester, ...	50 ·2	7	51	53	0	54	109
Leyton, ...	50 ·2	35	50	34	0	1 W.	97
Aldershot, ...	50 ·1	34	50	15	0	45	325
Little Bridy, . . .	50 ·0	—	50	41		—	367
Douglas (Man), . .	50 ·0	0	54	12	4	30	—
Worcester, ...	50 ·0	50	52	13	2	12	130
Wisbeach, ...	50 ·0	8	52	41	0	9 E.	14
Chatham, ...	50 ·0	12	51	23	0	32	160
Canterbury, . . .	50 ·0	8	51	17	1	5	80
Hereford, ...	50 ·0	32	52	14	2	28 W.	260
Diss, ...	50 ·0	22	52	25	1	7 E.	110
Leamington, . . .	50 ·0	62	51	17	1	2 W.	195
Royston, ...	49 ·9	47	52	2		47	269
Boston, ...	49 ·9	7	52	59	0	2	20
Hartwell, ...	49 ·8	70	51	49	0	50	250
Norwich, ...	49 ·8	16	52	38	1	18 E.	50
Cheltenham, . . .	49 ·8	34	51	34	2	4 W.	—
Cardington, . . .	49 ·7	64	52	7	0	2	109
Hawarden, . . .	49 ·7	15	53	11	3	4	270
Oxford, ...	49 ·7	64	51	46	1	16	210
Great Malvern, . .	49 ·6	40	52	11	2	20	536
Lampeter, ...	49 ·4	14	52	7	4	5	420

STATION.	Mean Temperature.	Distance from Sea in miles.	Latitude.		Longitude.		Height above Sea in feet.
	Fahrenheit.		°	′	°	′	
Bellassalla (Man), .	49°·4	3	54	6	4	37 W.	103
Downside, ...	49 ·3	16	51	23	—		607
Grantham, ...	49 ·3	30	52	55	0	39	181
Nottingham, . . .	49 ·2	60	52	58	1	7	181
Derby, ...	49 ·2	68	52	56	1	28	174
Holkham, ...	49 ·1	2	52	57	0	48 E.	39
Great Berkhamstead,	49 ·1	60	51	45	0	27	370
Leeds, ...	49 ·1	60	53	48	1	33 W.	137
Bywell, ...	49 ·1	20	54	37	1	40	87
Manchester, . . .	48 ·9	30	53	29	2	16	123
Wakefield, ...	48 ·9	59	53	41	1	29	115
Cockermouth, . . .	48 ·8	0	54	39	3	23	148
Silloth, ...	48 ·5	1	54	52	3	23	28
Belvoir, ...	48 ·5	33	52	54	0	47	260
Girvan, ...	48 ·4	0	55	15	4	50	27
York, ...	48 ·2	27	54	58	1	5	50
Cardross, ...	48 ·2	4	55	58	4	38	80
Ackworth, ...	48 ·1	52	53	39	1	20	—
Greenock, ...	48 ·1	2	55	57	4	45	64
Cargan, ...	48 ·0	1	55	0	3	37	85
Carlisle, ...	48 ·0	10	54	53	2	55	104
Stoneyhurst, . . .	48 ·0	20	53	51	2	28	381
Otley, ...	48 ·0	61	53	54	1	41	205
Ballock, ...	47 ·8	12	56	1	4	35	94
Auchendrain, . . .	47 ·8	—	55	27	4	37	97
Cairndrew, ...	47 ·7	5	56	16	4	56	25

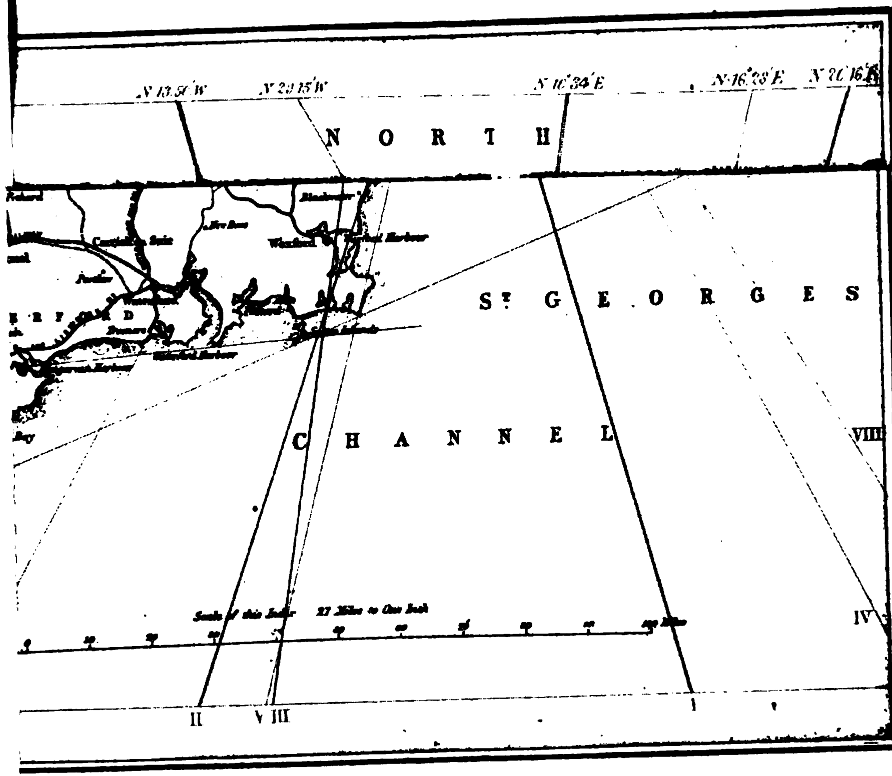
Station.	Mean Temperature.	Distance from Sea in miles.	Latitude.		Longitude.		Height above Sea in feet.
	Fahrenheit.		°	′	°	′	
New Malton, . . .	47°·6	18	54	8	0	47 W.	—
Easedale, ...	47 ·7	0	56	18	5	39	25
Dumfries, ...	47 ·6	8	55	3	3	36	183
Inveresk, ...	47 ·6	—	55	56	3	3	90
Durham, ...	47 ·5	12	54	46	1	35	354
Dalkeith, ...	47 ·5	3	55	54	3	4	190
Paisley, ...	47 ·5	20	55	50	4	27	88
Millnergraden, . .	47 ·5	—	55	42	2	12	100
Callton Moss, . . .	47 ·5	—	56	8	5	30	65
Gainsborough, . . .	47 ·4	34	53	24	0	47	—
Eallabus, ...	47 ·4	0	56	0	5	20	71
East Linton, . . .	47 ·4	—	55	59	2	39	90
Eyemouth, ...	47 ·4	0	55	52	2	5	16
Keswick, ...	47 ·3	18	54	33	3	9	240
Oban, ...	47 ·3	1	56	25	5	30	48
Forres, ...	47 ·3	4	57	37	3	36	53
Pittenween, . . .	47 ·3	0	56	13	2	44	75
Barry, ...	47 ·2	2	56	31	2	45	38
Smenton, ...	47 ·2	4	56	0	2	40	100
Perth, ...	47 ·2	20	56	23	3	26	66
Glasgow, ...	47 ·1	26	55	53	4	18	180
Kirkpatrick, . . .	47 ·1	—	55	58	3	27	350
Edinburgh, ...	47 ·1	2	55	56	3	10	270
Montrose, ...	47 ·1	1	56	43	2	26	14
Drumlauwig, . . .	47 ·1	25	55	17	3	48	192
Kendal, ...	47 ·0	13	54	17	2	46	130

STATION.	Mean Temperature.	Distance from Sea in miles.	Latitude.		Longitude.		Height above Sea in feet.
	Fahrenheit.		°	′	°	′	
Arnott Hill, . . .	47°·0	—	36	0	3	43 W.	135
Trinity Gask, . . .	47 ·0	—	56	20	3	42	133
Averdour, ...	47 ·0	—	56	3	3	18	60
Arbroath, ...	47 ·0	0	56	34	2	35	71
High Ho Alnwick, .	47 ·0	10	55	25	1	43	360
Stirling, ...	46 ·9	30	56	6	3	55	233
Wick, ...	46 ·9	1	58	29	3	9	—
Elgin, ...	46 ·9	5	57	38	3	19	50
Culloden, ...	46 ·9	4	57	30	4	7	104
Dundee, ...	46 ·9	2	56	29	2	57	164
Otter House, . . .	46 ·8	—	56	0	5	20	130
Balfour, ...	46 ·8	—	56	11	3	5	130
Galashiels, ...	46 ·8	32	55	37	2	50	390
Slogarie, ...	46 ·7	—	—		—		—
Aberdeen, ...	46 ·7	0	54	59	4	8	300
Nookton, ...	46 ·6	—	56	11	3	3	80
Dallar, ...	46 ·5	12	56	10	3	39	174
Baillieston, ...	46 ·5	—	55	52	4	6	242
Yester, ...	46 ·5	—	55	54	2	44	420
Dunrobin, ...	46 ·5	0	57	58	3	59	9
Portree (Skye), . .	46 ·5	1	57	25	6	11	50
Thurston, ...	46 ·4	—	55	57	2	28	327
Scourie, ...	46 ·4	0	58	22	5	8	26
Makerstown, . . .	46 ·1	26	55	35	2	31	211
Glencairn, ...	46 ·1	—	—		—		—
Stranver, ...	46 ·1	—	56	21	4	20	470

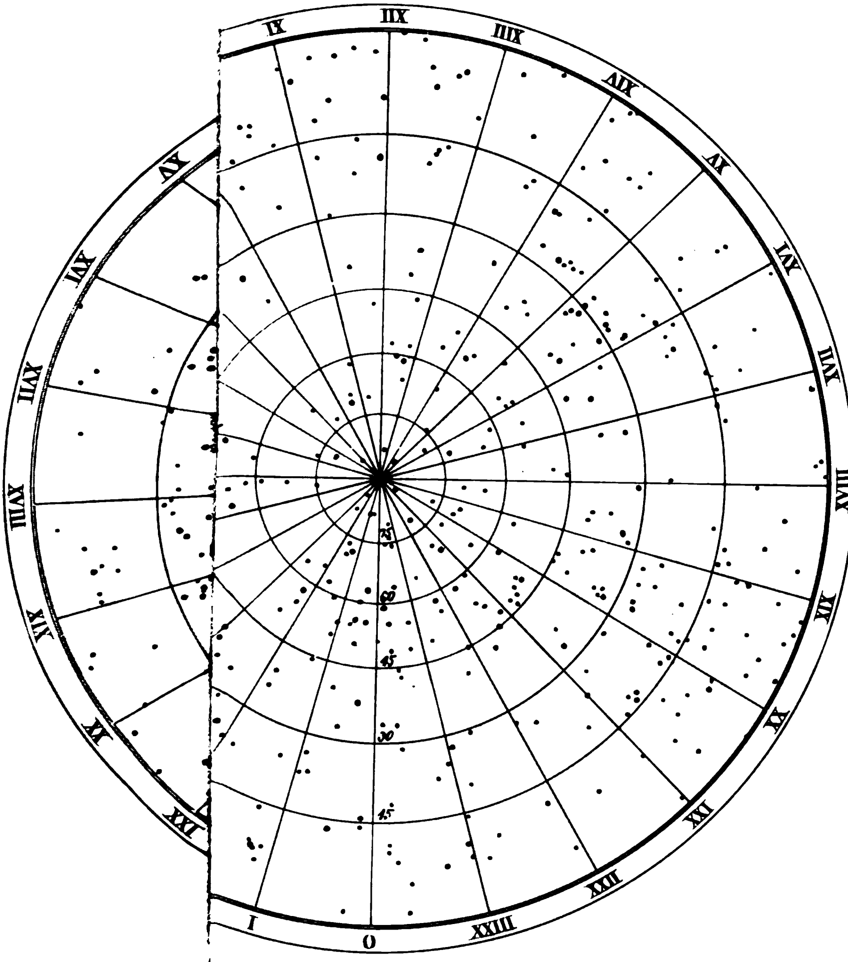
Station.	Mean Temperature.	Distance from Sea in miles.	Latitude.	Longitude.	Height above Sea in feet.
	Fahrenheit.		° ′	° ′	
Kettins, ...	46°·1	—	56 32	3 16 W.	228
Stornaway (Lewis), .	46 ·0	0	58 12	6 21	70
Stobocastle, . . .	45 ·9	—	55 37	3 20	605
Kirkwall (Orkney), .	45 ·9	0	58 58	2 58	10
Mut Hill, ...	45 ·7	—	56 20	3 50	245
Sandwick (Orkney), .	45 ·8	0	59 2	3 18	94
Sunnyside, ...	45 ·8	—	56 45	2 29	200
Thirlstane, ...	45 ·6	22	55 43	2 47	553
Bressay (Shetland), .	45 ·4	0	60 10	1 10	25
Deanstone, ...	45 ·7	—	56 13	4 4	130
Marchmont, . . .	45 ·4	—	55 44	2 25	500
Fettercairn, . . .	45 ·2	9	56 53	2 34	247
The Glen, ...	45 ·2	—	55 35	3 9	765
Bowhill, ...	45 ·2	—	55 32	2 55	597
Corrymony, . . .	47 ·9	24	57 20	4 30	650
Douglas Castle, . .	44 ·8	30	55 35	3 52	783
Ballater, ...	44 ·6	30	57 4	3 3	666
Allenheads, ...	47 ·3	46	54 49	2 15	1360
New Pilsligo, . .	44 ·3	6	57 35	2 9	501
Castle News, . . .	44 ·1	34	57 12	3 0	68
Bogside, ...	43 ·7	—	57 18	2 45	894
Braemar, ...	43 ·6	45	57 0	3 24	1114
North Esk (Reservoir),	43 ·3	16	55 48	3 21	1150
Wanlock Head, . .	42 ·2	33	55 24	3 48	1334

IRELAND.

STATION.	Mean Temperature.	Distance from Sea in miles.	Latitude.		Longitude.		Height above Sea in feet.
	Fahrenheit.		°	′	°	′	
Cahirciveen, . . .	52°·0	2	51	56	10	13 W.	52
Castletownsend, . .	51 ·8	2	51	33	9	9	18
Queenstown, . . .	51 ·5	4	51	50	8	19	—
Cork, ...	51 ·2	12	51	54	8	29	28
Valentia, ...	51 ·1	1	51	54	10	25	—
Westport, or Inisgort,	51 ·4	0	53	50	9	37	17
Dunmore, ...	51 ·3	0	52	8	6	59	—
Limerick, ...	50 ·8	40	52	40	8	38	—
Scattery, ...	50 ·8	10	52	36	9	30	—
Killybegs, ...	50 ·3	0	54	34	8	27	—
Buttevant, ...	50 ·2	30	52	13	8	41	—
Courtown, ...	50 ·0	0	52	39	6	13	34
Monkstown (Dublin),	50 ·0	1	53	19	6	11	—
Killough, ...	49 ·9	0	54	13	5	40	23
Dublin, ...	49 ·7	4	53	21	6	15	19
Donaghadee, . . .	49 ·3	0	54	38	5	33	16
Derry, ...	48 ·9	14	55	0	7	20	—
Portrush, ...	48 ·8	8	55	13	6	41	29
Buncrana, ...	48 ·7	4	55	8	7	27	48
Belfast, ...	48 ·5	10	54	37	5	57	—
Armagh, ...	48 ·3	30	54	21	6	39	—
Milltown, Down, . .	48 ·4	17	54	23	6	16	—
Enniskillen, . . .	48 ·4	30	54	20	7	34	—
Athlone, ...	48 ·4	72	53	24	7	53	—
Athy, ...	48 ·1	35	53	0	6	58	200
Curragh, ...	47 ·8	30	53	9	6	48	—
Antrim, ...	47 ·8	20	54	43	6	8	—
Markree, ...	47 ·8	18	54	14	8	28	132
Portarlington . . .	47 ·0	45	53	9	7	12	230

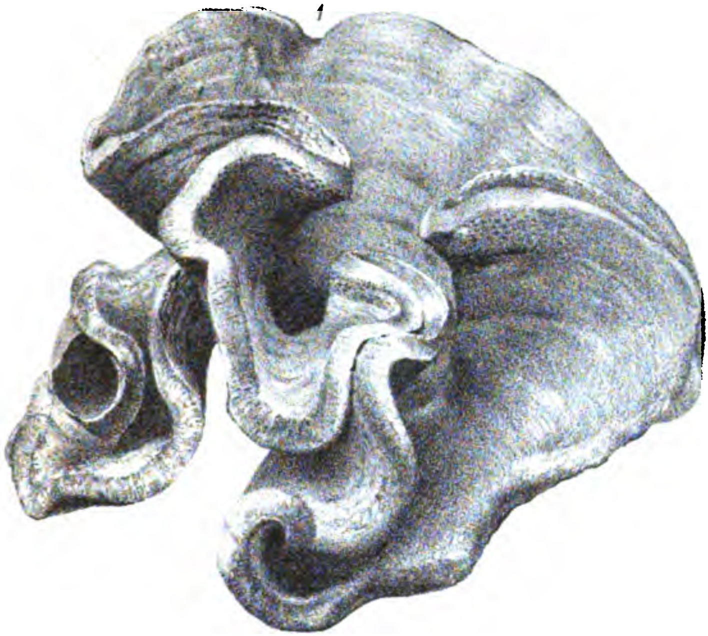

N 13.50 W
N 23.15 W
N 10.34 E
N 16.28 E
N 20.16 E
NORTH
St. GEORGES
CHANNEL
Wexford
Waterford Harbour
Scale of this Index 27 Miles to One Inch
0
10
20
30
40
50
60
70
80
90
100 Miles
I
II
III
IV
V
VIII

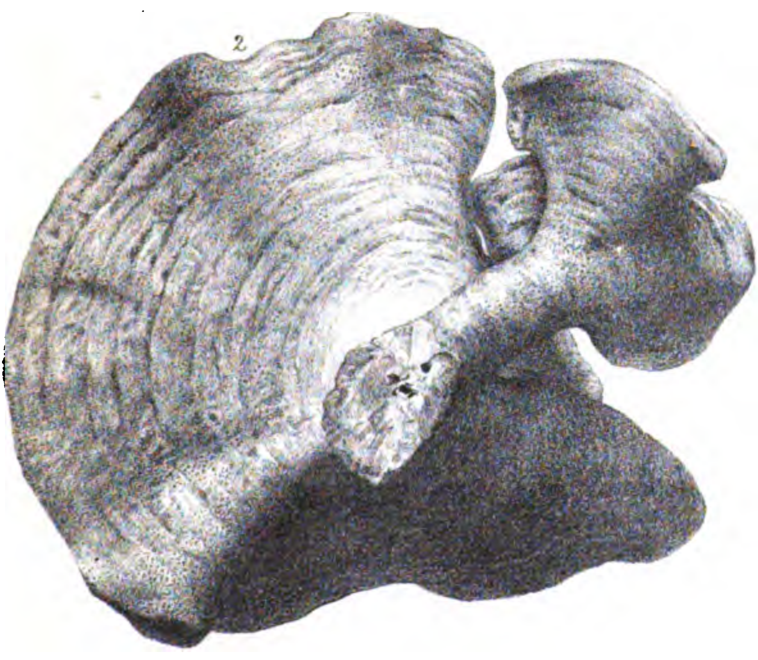
; Variable Stars.



NORTH

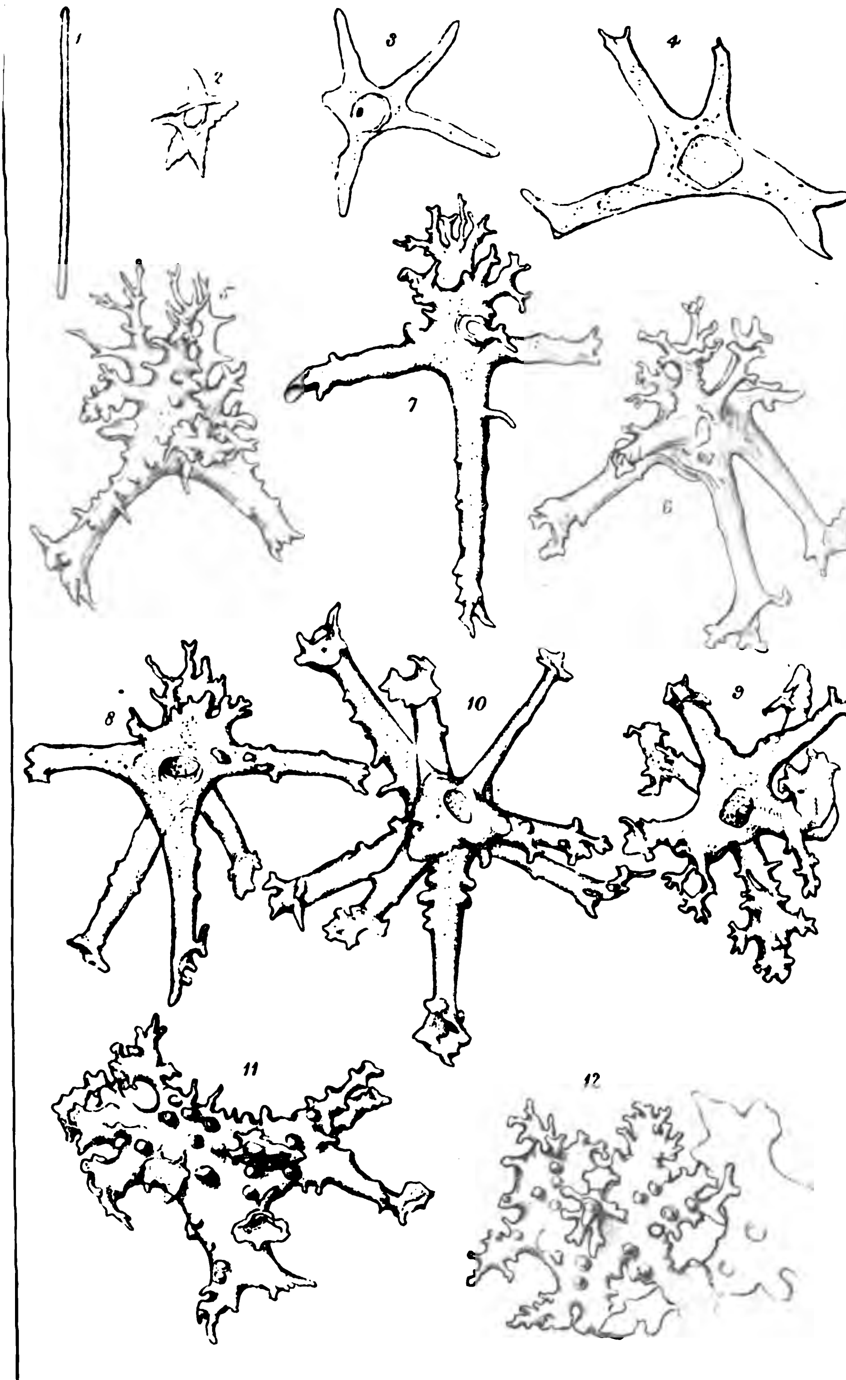
J. E. Gore, *Del.* Forster & Co., Lith., Dublin





T. H. Thomas, del. et lith. Forster & Co., Imp., Dub

"VETULINA STALACTITES."—(O. SCHMIDT.)



W. J. Sollas, del. FORSTER & Co., Imp., DUBLIN T. H. Thomas,

"SKELETAL STRUCTURES OF VETULINA STALACTITES."

Plate VI.

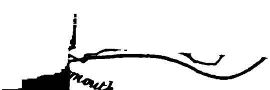
MAP ILLUSTRATING

BUTION OF HEAT

OVER

ITISH ISLANDS,

HENNESSY, F.R.S.



FORSTER & CO., LITH. DUBLIN.

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T.

LIST

OF THE

COUNCIL AND OFFICERS

AND

MEMBERS

OF THE

ROYAL IRISH ACADEMY;

DUBLIN,

26TH OF MAY, 1884.

DUBLIN:
ACADEMY HOUSE, 19, DAWSON STREET.

1884

THE ROYAL IRISH ACADEMY,

A.D. 1884.

Patron:

HER MAJESTY THE QUEEN.

Visitor:

HIS EXCELLENCY THE LORD LIEUTENANT OF IRELAND.

ROYAL IRISH ACADEMY.

President:

(*First elected, 16th of March*, 1882.)

SIR SAMUEL FERGUSON, Q.C., LL.D.

The Council:

(*Elected 15th of March*, 1884.)

The Council consists of the Committees of Science and of Polite Literature and Antiquities.

Committee of Science (Eleven Members):

	Elected.	
(1)	Mar., 1878	EDMUND W. DAVY, M.A., M.D.
(2)	„ 1879	JOSEPH P. O'REILLY, C.E.
(3)	„ 1880	JOHN CASEY, LL.D., F.R.S.
(4)	„ 1881	FRANCIS A. TARLETON, LL.D., F.T.C.D.
(5)	„ 1881	GEORGE SIGERSON, M.D.
(6)	Nov., 1881	CHARLES R. C. TICHBORNE, PH.D.
(7)	Mar., 1882	SIR ROBERT KANE, LL.D., F.R.S.
(8)	„ 1883	REV. JOHN H. JELLETT, D.D., Provost T.C.D.
(9)	„ 1883	ALEXANDER G. MORE, F.L.S.
(10)	Nov., 1883	ED. PERCEVAL WRIGHT, M.A., M.D. (*Sec. of Comm.*)
(11)	Mar., 1884	REV. SAMUEL HAUGHTON, M.D., F.R.S., S.F.T.C.D.

Committee of Polite Literature and Antiquities (Ten Members):

(12)	Mar., 1870	ROBERT ATKINSON, LL.D. (*Sec. of Comm.*)
(13)	„ 1878	JOHN T. GILBERT, F.S.A.
(14)	Nov., 1878	REV. MAXWELL H. CLOSE, M.A.
(15)	Mar., 1879	JOHN R. GARSTIN, M.A., F.S.A.
(16)	„ 1880	JOHN KELLS INGRAM, LL.D., F.T.C.D.
(17)	„ 1881	WILLIAM FRAZER, F.R.C.S.I.
(18)	„ 1882	DAVID R. PIGOT, M.A.
(19)	„ 1883	WILLIAM M. HENNESSY.
(20)	„ 1884	SIR PATRICK J. KEENAN, C.B., K.C.M.G.
(21)	„ 1884	PATRICK W. JOYCE, LL.D.

Vice-Presidents:

(*As nominated by the President, 15th of March, 1884: with the dates from which they have continuously been re-appointed.*)

(1) JOHN CASEY, LL.D., F.R.S., (1880).
(2) D. R. PIGOT, M.A., (1883).
(3) JOHN KELLS INGRAM, LL.D., F.T.C.D., (1884).
(4) F. A. TARLETON, LL.D., F.T.C.D., (1884).

Officers:

(*Elected annually by the Academy; with date of first election.*)

TREASURER, ...	REV. MAXWELL H. CLOSE, M.A. (1878).
SECRETARY, ...	ED. PERCEVAL WRIGHT, M.A., M.D., (1883).
SECRETARY OF THE COUNCIL, ...	ROBERT ATKINSON, LL.D., (1878).
SECRETARY OF FOREIGN CORRESPONDENCE,	JOSEPH P. O'REILLY, C.E., (1880).
LIBRARIAN, ...	JOHN T. GILBERT, F.S.A., (1878).

Clerk of the Academy (*elected annually by the Academy*)	ROBERT MACALISTER, LL.B. (1882).
Curator, Museum-Clerk, and Housekeeper, .	MAJOR ROBT. MACENIRY, (1872).
Assistant Accountant, ...	MR. ROBERT G. ROBSON, (1880).
Library Clerk, ...	MR. J. J. MACSWEENEY, (1869).
Serjeant-at-Mace, ...	MR. J. J. MACSWEENEY, (1877).

Committees appointed by Council:

These Committees are composed of the Members of Council, to whose names the subjoined numbers are prefixed in the foregoing list:

Museum, . .	Committee of Polite Literature and Antiquities. *Sec.* No. 12.
Publication, .	1, 4, 10 (*Sec.*), 11, 12, 13, 14, 16.
Library, . .	1, 2, 6, 9, 12, 13 (*Sec.*), 14, 17, 18, 20, 21.
Irish Manuscripts,	3, 5, 12 (*Sec.*), 13, 14, 16, 19, 21.
Economy & House,	2, 4, 5, 9, 13, 14 (*Sec.*), 15, 17, 19, 20.

MEMBERS OF THE ROYAL IRISH ACADEMY.

ORDINARY MEMBERS.

The sign * is prefixed to the names of Life Members.
The sign † indicates the Members who have not yet been formally admitted.
The sign § indicates the Members who have contributed papers to the Transactions of the Academy.
N.B.—The names of *Members whose addresses are not known* to the Secretary of the Academy, are printed in italics. He requests that they may be communicated to him.

Date of Election.	
1843. April 10	*§Allman, George James, M.D. (Dub. and Oxon.), LL.D., F.L.S., F.R.C.S.I., F.R.SS., Lond. & Edin., Royal Medalist R.S., 1873. *Ardmore, Parkstone, Dorsetshire; Athenæum Club, London.*
1871. June 12	*†Amherst, William Amhurst Tyssen-, D.L., M.P., F.S.A., M.R.S.L. *Didlington Hall, Brandon, Norfolk.*
1873. Jan. 13	Andrews, Arthur. *Newtown House, Blackrock, Co. Dublin.*
1839. Jan. 14	*§Andrews, Thomas, M.D., LL.D. (Edin.), F.R.S., Hon. F.R.S.E., F.C.S., Royal Medalist, R.S., 1844. *Fort William Park, Belfast.*
1828. April 28	*§Apjohn, James, M.D., F.R.S., F. and Hon. F., K.Q.C.P.I., F.C.S. *South Hill, Blackrock, Co. Dublin.*
1870. Jan. 10	*Archer, William, F.R.S. *National Library, Dublin.*
1870. April 11	†Ardilaun, Right Hon. Arthur, Baron, M.A., D.L. *Ashford, Cong, Co. Galway; St. Anne's, Clontarf, Co. Dublin.*
1883. Nov. 12	†Arran, Right Hon. Philip York Gore, Earl of, K.P., *Castle Gore, Ballina, Co. Mayo;* 27 *Chesham-street, London, S.W.*
1884. May 12	†Atkinson, George Mounsey. 28, *St. Oswald's-road, West Brompton, London.*
1875. Jan. 11	Atkinson, Robert, LL.D., Professor of Sanskrit and Comparative Philology, Dublin University, Secretary of Council of the Academy. *Clareville, Upper Rathmines, Co. Dublin.*
1872. April 8	Baily, William Hellier, F.L.S., F.G.S., Geological Survey of Ireland, Demonstrator in Palæontology, Royal College of Science, Dublin. 33, *Moyne-road, Rathmines, Co. Dublin.*
1872. June 24	Baldwin, Thomas, 67, *Pembroke-road, Dublin.*

Date of Election.	
1840. April 13	*Ball, John, M.A., F.R.S., F.L.S. 10, *Southwell Gardens, South Kensington, London, S.W.*
1870. Jan. 10	§Ball, Robert Stawell, LL.D., F.R.S., F.R.A.S., Andrews Professor of Astronomy in the University of Dublin, and Royal Astronomer of Ireland. *The Observatory, Dunsink, Co. Dublin.*
1883. June 11	Ball, V., M.A., F.R.S., Director, Science and Art Museum, Dublin. 1, *Raglan-road, Dublin.*
1842. Jan. 10	*Banks, John T., M.D., F.K.Q.C.P.I. 45, *Merrion-square, East, Dublin.*
1868. Jan. 13	*Barker, W. Oliver, M.D., M.R.C.S.E. 6, *Gardiner's-row, Dublin.*
1874. May 11	Barrett, William F., F.R.S.E., Professor of Physics, Royal College of Science, Dublin. 6, *De Vesci-terrace, Kingstown.*
1866. May 14	Barrington, Sir John, D.L. *Santa Severina, Killiney. Co. Dublin.*
1884. Feb. 11	†Barrington, Richard Manliffe, M.A., LL.B. *Fassaroe, Bray.*
1880. Feb. 9	*†Barry, Michael, M.D. 16, *Albion-street, Hyde-park, London, W.*
1880. Feb. 9	*Barter, Rev. John Berkeley, F.R.G.S.I., F.R.H.A.A.I. *Benmore Rectory, Enniskillen.*
1879. Feb. 10	*Beaney, James G., M.D. *Melbourne, Australia.*
1865. Jan. 9	*Beauchamp, Robert Henry, 25, *Fitzwilliam-square, South, Dublin.*
1863. April 27	*Belmore, Right Hon. Somerset Richard, Earl of, M.A., D.L., K.C.M.G. *Castle Coole, Enniskillen.*
1884. May 12	Bell, Hamilton, F.R.G.S.I. 46 *North Great George's-street, Dublin.*
1866. June 11	Bennett, Edward Hallaran, M.D., M.Ch., F.R.C.S.I., F.R.G.S.I., Professor of Surgery in the University of Dublin. 26, *Lower Fitzwilliam-street, Dublin.*
1851. June 9	†Beresford, Right Hon. and Most Rev. Marcus G., D.D., D.C.L., Lord Archbishop of Armagh, Primate of all Ireland. *The Palace, Armagh.*
1876. Jan. 10	*Blake, John A., M.P. 2, *Saville-row, London, W.*
1871. Jan. 9	Bourke, Very Rev. (Canon) Ulick J., P.P. *Claremorris.*
1873. April 14	†Boyd, Michael A., F.R.C.S.I., L.K.Q.C.P.I. 90, *Upper George's-street, Kingstown, Co. Dublin.*
1854. April 10	**Brady, Cheyne.*
1849. April 9	*Brady, Daniel Fredk., F.R.C.S.I., M.R.C.S.E., J.P. *La Choza, Rathgar-road, Co. Dublin.*
1858. April 12	†Brooke, Thomas, D.L. *The Castle, Lough Eske, Co. Donegal.*
1878. May 13	†Browne, John. *Drapersfield, Cookstown, Co. Tyrone.*

Date of Election.	
1851. Jan. 13	*Browne, Robert Clayton, M.A., D.L. *Browne's Hill, Carlow.*
1874. Feb. 9	†Burden, Henry, M.A., M.D., M.R.C.S.E. 8, *Alfred-street, Belfast.*
1854. April 10	Burke, Sir John Bernard (Ulster), LL.D., C.B. *Tullamaine Villa, Upper Leeson-street, Dublin.*
1855. Jan. 8	*Butcher, Richard G., M.D., F.R.C.S.I., M.R.C.S.E. 19, *Lower Fitzwilliam-street, Dublin.*
1876. May 8	Byrne, William H., C.E., *Sunbury Gardens, Palmerston-park, Upper Rathmines, Co. Dublin.*
1862. April 14	Campbell, John, M.D., Professor of Chemistry, Catholic University. 161, *Rathgar-road, Co. Dublin.*
1873. May 12	†Carlingford, Right Hon. Chichester, Baron, K.P., Lord Lieutenant of Essex. *Red House, Ardee;* 7, *Carlton Gardens, London, S.W.*
1838. Feb. 12	*Carson, Rev. Joseph, D.D., S.F.T.C.D., F.R.G.S.I. 18, *Fitzwilliam-place, Dublin.*
1876. Jan. 10	†Carton, Richard Paul, Q.C. 35, *Rutland-square, West, Dublin.*
1883. June 11	†Cartwright, Henry Edward, LL.B., J.P. *Manor House, Magherafelt.*
1866. May 14	§Casey, John, LL.D., F.R.S., Professor of Higher Mathematics and Mathematical Physics, Catholic University, a Vice-President of the Academy. 86, *South Circular-road, Dublin.*
1878. May 13	*Cathcart, George L., M.A., F.T.C.D. 106, *Lower Baggot-street, Dublin.*
1842. June 13	*Chapman, Sir Benjamin J., Bart., Lieutenant of Westmeath. *Killua Castle, Clonmellon.*
1864. Jan. 11	Charlemont, Right Hon. James Molyneux, Earl of, K.P., Lieutenant of the County Tyrone. *Roxborough Castle, Moy, Co. Tyrone.*
1876. April 10	*Clarke, Rev. Francis E., M.A., M.D., LL.D., L.K.Q.C.P.I., M.R.C.S.E. *The Rectory, Boyle, Co. Roscommon.*
1841. Jan. 11	*†Clermont, Right Hon. Thomas, Baron, D.L., *Ravensdale Park, Newry.*
1867. May 13	*Close, Rev. Maxwell H., M.A., F.R.G.S.I., F.G.S., Treasurer of the Academy. 40, *Lower Baggot-street, Dublin.*
1835. Nov. 30	**Cole, Owen Blayney, D.L.*
1882. Feb. 13	*†Collins, Charles MacCarthy. *Union Bank of Australia, Melbourne.*
1882. June 26	*†Collum, Rev. Hugh Robert, F.S.S. *Leigh Vicarage, Tonbridge, Kent.*

Date of Election.	
1882. Feb. 13	Comerford, Rev. Michael, P.P. *Monasterevan, Co. Kildare.*
1866. April 9	†Cooper, Lieut. Col. Edward H., Lieutenant of Co. Sligo. *Markree Castle, Collooney.*
1856. April 14	Copland, Charles. *Royal Bank, Foster-place, Dublin; 7, Longford-terrace, Monkstown, Co. Dublin.*
1878. June 24	Corbet, William J., M.P. *Springfarm, Delgany.*
1864. May 9	†Cotton, Charles Philip, B.A., C.E., F.R.G.S.I., *Ryecroft, Bray.*
1876. Apr. 10	Cox, Michael Francis, M.A., L.R.C.S.I. 97, *Stephen's-green, South, Dublin.*
1882. Feb. 13	*Cox, William Sidney, C.E. 66, *George-street, Limerick.*
1884. May 12	†Cranny, John Joseph, A.B., M.D., F.R.C.S.I. 17 *Merrion-square, North, Dublin.*
1857. Aug. 24	*§Crofton, Denis, B.A., 8, *Mountjoy-square, North, Dublin.*
1866. June 11	Cruise, Francis R., M.D., F.K.Q.C.P.I., M.R.C.S.E. 93, *Merrion-square, West, Dublin.*
1870. Apr. 11	Cruise, Richard Joseph, F.R.G.S.I., Geological Survey of Ireland. *Millburn, Buncrana, Co. Donegal;* 14, *Hume-street, Dublin.*
1876. Nov. 13	*†Dalway, Marriott R., D.L. *Bella Hill, Carrickfergus.*
1853. April 11	*Davies, Francis Robert, K.J.J. *Hawthorn, Carysfort-avenue, Blackrock, Co. Dublin.*
1855. May 14	*§Davy, Edmund W., M.A., M.D., Prof. of Med. Jurisprudence, Royal College of Surgeons, Ireland. 1, *Fortfield Terrace, Templeogue, Co. Dublin.*
1846. April 13	*D'Arcy, Matthew P., M.A., D.L. 40, *Merrion-square, East, Dublin.*
1876. Jan. 10	Day, Robert, Jun., F.S.A. *Sidney-place, Cork.*
1876. Jan. 10	Deane, Thomas Newenham, R.H.A., F.R.I.A.I. 3, *Upper Merrion-street, Dublin.*
1884. Feb. 11	*Delany, Very Rev. William, S.J., President, University College. *Stephen's-green, South, Dublin.*
1860. Jan. 9	*Dickson, Rev. Benjamin, D.D. 3, *Kildare-place, Dublin.*
1876. Feb. 14	Dillon, William. *Sedalia, Douglas County, Colorado, U.S.A.*
1876. Jan. 10	*§Doberck, William, Ph.D. *The Observatory, Hong Kong.*
1851. Jan. 13	*Dobbin, Rev. Orlando T., B.D., LL.D. *St. George's-terrace, Gravesend, Kent.*
1879. June 9	*Doherty, William J., C.E., J.P. *Clonturk House, Drumcondra, Co. Dublin.*
1876. June 26	§Draper, Harry N., J.P., F.C.S. *Esterel, Temple-road, Upper Rathmines, Co. Dublin.*

Date of Election.	
1843. Jan. 9	*Drury, William Vallancey, M.D. *Bournemouth.*
1861. Feb. 11	Duncan, James Foulis, M.D., F.K.Q.C.P.I. 8, *Upper Merrion-street, Dublin.*
1867. Feb. 11	Ellis, George, M.B., F.R.C.S.I. 91, *Lower Leeson-street, Dublin.*
1841. April 12	*Emly, Right Hon. William, Baron, Lieutenant of the County Limerick. *Tervoe, Limerick; Athenæum Club, London, S.W.*
1846. Jan. 12	*Enniskillen, Right. Hon. William Willoughby, Earl of, LL.D., D.C.L., D.L., F.R.S., F.R.G.S.I., one of the Trustees of the Hunterian Museum, R.C.S., London. *Florence Court, Co. Fermanagh;* 65, *Eaton-place, London, S.W.*
1867. April 8	*Farrell, Thomas A., M.A. 37 *Merrion-square, East.*
1834. Mar. 15	*§Ferguson, Sir Samuel, LL.D. (Dub. and Edin.), Q.C., President of the Academy. 20, *North Great George's-street, Dublin.*
1842. Jan. 10	*Ferrier, Alexander. *Knockmaroon Lodge, Chapelizod, Co. Dublin.*
1878. Feb. 11	Fitzgerald, George F., M.A., F.T.C.D., F.R.S. 40, *Trinity College, Dublin.*
1870. May 23	†FitzGibbon, Abraham, M.I.C.E. London. *Moorside, Bushey Heath, Watford, Herts.*
1875. Jan. 11	Fitzpatrick, William John, LL.D., F.S.A., J.P. 49, *Fitzwilliam-square, West, Dublin.*
1881. Jan. 10	Fletcher, Joseph, F.C.SS., London and Berlin. *Sandymount Castle, Co. Dublin.*
1860. Jan. 9	Foley, William, M.D., M.R.C.S.E. *Kilrush.*
1874. Feb. 9	†Foster, Rev. Nicholas. *Ballymacelligott Rectory, Tralee.*
1876. Feb. 14	Fottrell, George. 8, *North Great George's-street, Dublin.*
1838. Nov. 12	**Frazer, George A., Captain R.N.*
1883. Nov. 12	Frazer, Robert Watson, LL.B., Assoc. R.C.Sc.I. *Madras.*
1866. May 14	Frazer, William, F.R.C.S.I., F.R.G.S.I. 20, *Harcourt-street, Dublin.*
1865. April 10	†Freeland, John, M.D. *Antigua, West Indies.*
1881. June 13	†Freeman, D.J., M.R.I.A.I. 34, *Dawson-street, Dublin.*
1847. May 10	*Freke, Henry, M.D. (Dub.), F.K.Q.C.P.I. 68, *Lower Mount-street, Dublin.*
1873. April 14	*†Frost, James, J.P. *Ballymorris, Cratloe, Co. Clare.*
1875. June 14	Furlong, Nicholas, M.D. *Lymington, Enniscorthy.*
1859. Jan. 10	Gages, Alphonse, Chev. L.H., F.R.G.S.I. *Royal College of Science, Dublin.*

Date of Election.	
1845. April 4	*Galbraith, Rev. Joseph Allen, M.A., S.F.T.C.D., F.R.G.S.I. 8, *Trinity College; 46, Lansdowne-road, Dublin.*
1878. May 13	Galloway, Robert, F.C.S. 47, *Leeson-park, Dublin.*
1880. June 28	Gannon, John Patrick. *Stephen's-green Club, Dublin.*
1863. Feb. 9	*Garstin, John Ribton, M.A., LL.B., F.S.A., F.R. Hist. Soc., Hon. F.R.I.A.I., D.L. *Braganstown, Castlebellingham, Co. Louth; Green-hill, Killiney, Co. Dublin.*
1855. April 9	*Gilbert, John Thomas, F.S.A., Hon. R.H.A., Librarian of the Academy. *Villa Nova, Blackrock, Co. Dublin.*
1876. May 8	Gillespie, William. *Racefield House, Kingstown, Co. Dublin.*
1875. April 12	*Gore, J. E., C.E., A.I.C.E., F.R.A.S., F.R.G.S.I., *Beltra, Ballisodare, Co. Sligo.*
1836. May 25	*Gough, Right Hon. George S., Viscount, M.A., D.L., F.L.S., F.G.S. *St. Helen's, Booterstown, Co. Dublin.*
1848. June 12	*Graham, Andrew, M.A. *Observatory, Cambridge.*
1876. April 10	Grainger, Rev. John (Canon), D.D. *Broughshane, Co. Antrim.*
1863. April 13	†Granard, Right Hon. George Arthur Hastings, Earl of, K.P. *Castle Forbes, Co. Longford.*
1837. April 24	*§Graves, Right Rev. Charles, D.D., F.R.S., Lord Bishop of Limerick. *The Palace, Henry-street, Limerick.*
1874. Feb. 9	Gray, William. 8, *Mount-Charles, Belfast.*
1867. April 8	Green, James Sullivan, Q.C. 83, *Lower Leeson-street, Dublin.*
1872. April 8	†Greene, John Ball, C.B., C.E., F.R.G.S.I., Commissioner of Valuation. 6, *Ely-place, Dublin.*
1882. Dec. 11	†Greer, Thomas, M.P., J.P., F.R.G.S.I. *Sea Park, Carrickfergus; Grove House, Regent's-park, London, N.W.*
1857. June 8	*Griott, Daniel G., M.A. 9, *Henrietta-street, Dublin.*
1873. Dec. 8	*Guinness, Edward Cecil, M.A., D.L. 80, *Stephen's-green, South, Dublin.*
1884. Jan. 14	Haddon, Alfred Cort, M.A., F.Z.S., Professor of Zoology in the Royal College of Sciensefor Ireland. 4, *Willow-bank, Kingstown.*
1875. Jan. 11	Hamilton, Edward, M.D., F.R.C.S.I. 120, *Stephen's-green, West, Dublin.*
1879. Dec. 8	Hamilton, Edwin, M.A. 40, *York-street, Dublin.*

Date of Election.	
1847. Jan. 11	Hancock, William Neilson, Q.C., LL.D. 43, *Upper Gardiner-street, Dublin.*
1837. Feb. 13	*§Hart, Andrew Searle, LL.D., Vice-Provost of Trinity College, Dublin. 14, *Lower Pembroke-street, Dublin.*
1861. May 13	Hatchell, John, M.A., J.P. *Fortfield House, Terenure, County Dublin.*
1845. Feb. 24	*§Haughton, Rev. Samuel, M.A., M.D., D.C.L. (Oxon.), LL.D. (Cantab. and Edin), F.R.S., F.G.S., F.R.G.S.I., F.K.Q.C.P.I., Honorary F.R.C.S.I., S.F.T.C.D., 31, *Upper Baggot-street, Dublin.*
1852. April 12	*Head, Henry H., M.D., F.K.Q.C.P.I., F.R.C.S.I., F.R.G.S.I. 7, *Fitzwilliam-square, East, Dublin.*
1870. April 11	†Heily, John Vickers, M.D. *Lisaduran Cottage, Rushworth, Melbourne, Victoria.*
1840. June 8	*Hemans, George Willoughby, C.E., F.G.S. 1, *Westminster Chambers, Victoria-Street, London, S.W.*
1851. Jan. 13	*§Hennessy, Henry, F.R.S., Professor of Applied Mathematics and Mechanics in the Royal College of Science for Ireland, Stephen's-green, Dublin. *Brookvale House, Donnybrook, Co. Dublin.*
1865. Feb. 13	*Hennessy, William Maunsell. 71, *Pembroke-road, Dublin.*
1873. Jan. 13	Hickie, James Francis, Lieut.-Col., J.P. *Slevoir, Roscrea, Co. Tipperary.*
1875. Jan. 11	*Hill, Arthur, B.E., A.R.I.B.A. 22, *George's-street, Cork.*
1867. Feb. 11	†Hill, John, C.E., F.R.G.S.I. *County Surveyor's Office, Ennis.*
1881. May 9	†Hillis, John David, M.D., F.R.C.S.I. *Demerara, West Indies.*
1882. June 26	Houston, Fred. H., F.R.G.S.I. 6, *Carlisle-terrace, Belfast.*
1824. Feb. 28	*Hudson, Henry, M.D., F.K.Q.C.P.I. *Glenville, Fermoy.*
1875. June 14	†Hume, Rev. Abraham, (Canon), D.C.L., LL.D. (Hon.); F.S.A.; F.R.S.N.A. (Copenhagen); Corr. F.S.A. Scot.; Hon. F.S.A. Newcastle; Member of the Philological and Eng. Dialect Societies; Ex-President Historic Soc. of Lancashire and Cheshire. *All Souls' Vicarage, Liverpool.*
1866. June 11	Hutton, Thomas Maxwell, J.P. 118, *Summerhill, Dublin.*
1847. Jan. 11	*Ingram, John Kells, LL.D., F.T.C.D., Librarian of Trinity College, Dublin, a Vice-President of the Academy. 2, *Wellington-road, Dublin.*

Date of Election.	
1879. April 14	†Ingram, Thomas Dunbar, LL.D. 13, *Wellington-road, Dublin.*
1841. April 12	*§Jellett, Rev. John Hewitt, D.D., F.R.G.S.I. Provost of Trinity College, Dublin, Royal Medalist R.S., 1881. *Provost's House, Trinity College, Dublin.*
1842. June 13	*Jennings, Francis M., F.G.S. *Brown-street, Cork.*
1867. April 8	Jephson, Robert H. 30, *Lansdowne-road, Dublin.*
1881. May 9	Jeremy, Rev. Daniel Davis, M.A. 4, *Appian Way, Dublin.*
1863. Jan. 12	Joyce, Patrick Weston, LL.D. *Lyre na Grena, Leinster-road, Rathmines, Co. Dublin.*
1878. May 13	*Kane, John F. *Leeson-park House, Dublin.*
1831. Nov. 30	*§Kane, Sir Robert, M.D., LL.D., F.K.Q.C.P.I., F.R.S., F.R.G.S.I., F.C.S., Royal Medalist R.S., 1841. *Fortlands, Killiney, Co. Dublin.*
1873. Dec. 8	*Kane, Robert Romney, M.A. *Dungiven, Ailesbury-road, Dublin.*
1865. April 10	Kane, William Francis De Vismes, M.A., J.P. *Sloperton Lodge, Kingstown; Drumreaske House, Monaghan.*
1870. June 13	*Keane, John P., C.E., Engineer, Public Works Department, Bengal. *Calcutta.*
1864. Nov. 14	*Keenan, Sir Patrick J., C.B., K.C.M.G., Resident Commissioner, Board of National Education, Ireland. *Delville, Glasnevin, Co. Dublin.*
1876. May 8	*Kelly, James Edward, M.D.*
1870. May 23	*Kelly, John, L.M. (Dub.). *University College Hospital, Calcutta.*
1846. April 13	*Kennedy, James Birch, J.P. *Cara, by Killarney.*
1874. May 11	†Kidd, Abraham, M.D. *Cooleen, Ballymena.*
1876. Feb. 14	*†Kildare, Most Hon. Gerald, Marquess of. *Carton, Maynooth.*
1875. June 14	†Kilgarriff, Malachy J., F.R.C.S.I. 30, *Harcourt-street, Dublin.*
1866. April 9	*Kinahan, Edward Hudson, J.P. 11, *Merrion-square, North, Dublin.*
1868. Jan. 13	Kinahan, George Henry, F.R.G.S.I., Geological Survey of Ireland. *Ramelton, County Donegal;* 14, *Hume-street, Dublin.*
1863. April 13	Kinahan, Thomas W., M.A. 24, *Waterloo-road, Dublin.*

Date of Election.	
1845. June 8	*King, Charles Croker, M.D., F.R.C.S.I., Medical Commissioner, Local Government Board. 34, *Upper Fitzwilliam-street, Dublin.*
1883. April 9	King, Henry, M.A. M.B., Deputy Surgeon-General. *Dalkey.*
1883. Feb. 12	Knott, John Freeman, F.R.C.S.I. 34, *York-street, Dublin.*
1883. Dec. 10	Knowles, W. J. *Flixton-place, Ballymena.*
1837. Feb. 13	*§Knox, George J. 2, *Coleshill-street, Eaton-square, London, S.W.*
1864. April 11	*Lalor, John J., F.R.G.S.I. *City Hall, Cork-hill, Dublin.*
1875. May 10	†Lane, Alexander, M.D. *Aghadowey, Ballymoney.*
1864. Jan. 11	LaTouche, J. J. Digges, M.A. 1, *Ely-place, Upper, Dublin.*
1857. May 11	*Lawson, Right Hon. James A., LL.D., Judge of the Queen's Bench Division of the High Court of Justice. 27, *Upper Fitzwilliam-street, Dublin.*
1857. April 13	*Leach, Lieut.-Colonel George A., R.E. 3, *St. James's-square, London, S.W.*
1845. Feb. 10	*LeFanu, William R., C.E. *Summerhill, Enniskerry, Co. Wicklow.*
1846. May 11	**Lefroy, George.*
1844. April 8	*†Leinster, His Grace Charles William, Duke of, President of the Royal Dublin Society. *Carton, Maynooth.*
1869. April 12	*Lenihan, Maurice, J.P. *Limerick.*
1853. April 11	Lentaigne, Sir John, C.B.. M.B., J.P., F.R.G.S.I. 1, *Great Denmark-street, Dublin.*
1870. June 13	Leonard, Hugh, F.G.S., F.R.G.S.I., Geological Survey of Ireland. *St. David's, Malahide-road, Dublin.*
1868. April 27	*Little, James, M.D., L.R.C.S.I., F.K.Q.C.P.I. 14, *Stephen's-green, North, Dublin.*
1876. Jan. 10	Lloyd, Joseph Henry, M.A., LL.D., Ph. D., F.R.S.L., F.S.A., M. Phil. Soc. 7, *Lower Gardiner-street, Dublin.*
1846. Jan. 12	**Lloyd, William T., M.D.*
1875. April 12	Lombard, James F., J.P. *South-hill, Rathmines, Co. Dublin.*
1838. Feb. 12	*Longfield, Right Hon. Mountifort, LL.D. (late Judge in the Landed Estates' Court). 47, *Fitzwilliam-quare, West, Dublin.*
1883. Feb. 12	Longfield, Thomas H. 19, *Harcourt-street, Dublin.*
1878. Feb. 11	*Lowry, Robert William, B.A. (Oxon.) D.L. *Pomeroy House, Dungannon Co. Tyrone.*

Date of Election.	
1868. Jan. 13	Lyne, Robert Edwin. *Royal Dublin Society, Kildare-street, Dublin.*
1851. May 12	*Lyons, Robert D., M.B., F.K.Q.C.P.I., D.L., M.P., Prof. of Medicine, Catholic University. 88, *Merrion-square, West, Dublin.*
1873. April 14	§Macalister, Alexander, M.A. (Cantab.), M.D. (Dub.), F.R.S., Fellow of St. John's College, and Professor of Anatomy in the University of Cambridge.
1871. Feb. 13	*Macartney, J. W. Ellison, M.P., J.P., D.L. *The Palace, Clogher.*
1884. May 12	†MacCarthy, Rev. Bartholomew, D.D. *Macroom, Co. Cork.*
1881. June 27	†McClintock, Rev. Francis Le Poer, M.A. (Cantab.), *Spencer Hill, Castlebellingham, Co. Louth.*
1874. Feb. 9	McClure, Rev. Edmund, M.A. 1, *Onslow-place, South Kensington, London, S. W.*
1873. Jan. 13	*McCready, Rev. Christopher, M.A. 56, *High-street, Dublin.*
1864. April 11	*McDonnell, Alexander, M.A., C.E., F.R.G.S.I. *Saltwell Hall, Gateshead-on-Tyne.*
1845. Feb. 24	**Macdonnell, James S., C.E.*
1827. Mar. 16	*MacDonnell, John, M.D., F.R.C.S.I., F.R.G.S.I. 32, *Upper Fitzwilliam-street, Dublin.*
1857. Feb. 9	*§McDonnell, Robert, M.D., F.R.C.S.I., F.R.S. 89, *Merrion-square, West, Dublin.*
1882. Feb. 13	McHenry, Alexander, Geological Survey of Ireland. 54, *Serpentine-avenue, Sandymount, Co. Dublin.*
1856. June 9	*†Mac Ivor, Rev. James, D.D., F.R.G.S.I. *Moyle, Newtownstewart.*
1876. April 10	MacIlwaine, Rev. William (Canon), D.D. *Ulsterville, Belfast.*
1881. Feb. 14	§Mackintosh, Henry William, M.A., Professor of Zoology and Comparative Anatomy in the University of Dublin. *Trinity College, Dublin.*
1871. April 10	Macnaghten, Colonel Sir Francis Edmund, Bart. (Late 8th Hussars), Vice-Lieutenant of the Co. Antrim. *Dundarave, Bushmills, Co. Antrim.*
1874. April 13	MacSwiney, Stephen Myles, M.D. 9, *Upper Merrion-street, Dublin.*
1884. Jan. 14	†McTernan, Rev. Stephen, P.P. *Killasnet, Manorhamilton.*
1846. Feb. 23	*Madden, Richard R., F.R.C.S. 1, *Vernon-terrace, Booterstown-avenue, Booterstown, Co. Dublin.*
1882. April 10	Mahony, Richard John, B.A. (Oxon.) D.L. *Dromore Castle, Kenmare, Co. Kerry.*

Date of Election.	
1880. May 10	†*Mahony, William Aloysius, L.K.Q.C.P.I., L.R.C.S. Edin.*
1874. Feb. 9	§Malet, John Christian, M.A. F.R.S., Professor of Mathematics. *Queen's College, Cork.*
1865. April 10	*Malone, Rev. Silvester, P.P., F.R.H.A.A.I. *Sixmilebridge, Co. Clare.*
1859. Jan. 10	*†Manchester, His Grace William Drogo, Duke of. 1, *Great Stanhope-street, London; Kimbolton Castle, St. Neot's, Hunts; The Castle, Tandragee.*
1871. Jan. 9	Maunsell, George Woods, M.A., D.L., Vice-President, Royal Dublin Society. 78, *Merrion-square, South, Dublin.*
1879. Feb. 10	Meldon, Austin, M.D. 15, *Merrion-square, North, Dublin.*
1884. May 12	Molloy, William Robert. 17 *Brookfield-terrace, Donnybrook.*
1861. Jan. 14	†Monck, Right Hon. Charles Stanley, Viscount, G.C.M.G., Lieutenant of Dublin City and County. *Charleville, Bray, Co. Wicklow.*
1858. Jan. 11	**Montgomery, Howard B., M.D.*
1869. Feb. 8	*Moran, Most Rev. Patrick F., D.D., Archbishop of Sydney. *New South Wales.*
1866. April 9	More, Alexander Goodman, F.L.S., Soc. Zoo. Bot. Vindob. Socius, Director of the Natural History Museum, Science and Art Department, Leinster House. 92, *Leinster-road, Rathmines, Co. Dublin.*
1874. Feb. 9	§Moss, Richard J., F.C.S., Keeper of the Minerals, Museum of Science and Art. 66, *Kenilworth-square, Rathgar.*
1884. May 12	*Murphy, Rev. Denis, S.J. *University College, Stephen's-green, Dublin.*
1876. April 10	†Myers, Walter. 21, *Queensboro-terrace, Hyde-park, London.*
1844. June 8	*Neville, John, C.E., F.R.G.S.I. *Roden-place, Dundalk.*
1854. May 8	Neville, Parke, C.E. 58, *Pembroke-road, Dublin.*
1873. Jan. 13	Nolan, Joseph, F.R.G.S.I., Geological Survey of Ireland. 47, *Great James's-street, Derry;* 14, *Hume-street, Dublin.*
1846. Jan. 12	*†Nugent, Arthur R. *Portaferry, Co. Down.*
1869. June 14	*O'Brien, James H. 4, *Hume-street, Dublin.*
1875. Jan. 11	O'Callaghan, J. J., F.R.I.A.I. 31, *Harcourt-street, Dublin.*
1867. June 10	O'Conor Don, Right Hon. The, D.L. *Clonalis, Castlerea, Co. Roscommon.*

Date of Election.	
1867. Jan. 14	O'Donel, Charles J., J.P. 47, *Lower Leeson-street, Dublin.*
1865. Apr. 10	O'Donnavan, William J., LL.D. *University Club, Dublin;* 79, *Kenilworth-square, Rathgar, Co. Dublin.*
1882. Apr. 10	O'Farrell, Francis J., F.C.S. *The Manor House, Dundrum.*
1869. Apr. 12	†O'Ferrall, Ambrose More, J.P. *Balyna House, Enfield, Co. Kildare.*
1866. Jan. 8	*O'Grady, Edward S., B.A., M.B., M. Ch., F.R.C.S.I. 105, *Stephen's-green, South, Dublin.*
1867. May 13	†O'Grady, Standish H. *Erinagh House, Castleconnell;* 2, *Southampton-st., Strand, London, W.C.*
1866. June 25	O'Hagan, Hon. John, M.A., Judge of the Supreme Court of Judicature in Ireland, and Judicial Commissioner Irish Land Commission. 22, *Upper Fitzwilliam-street, Dublin.*
1857. June 8	O'Hagan, Right Hon. Thomas, Baron, K.P. 34, *Rutland-square, West, Dublin.*
1869. Apr. 12	O'Hanlon, Very Rev. John, P.P. *Sandymount, Co. Dublin.*
1878. Feb. 11	O'Hanlon, Michael, L.K.Q.C.P.I. *Castlecomer, Co. Kilkenny.*
1869. Apr. 12	O'Laverty, Rev. James, P.P. *Holywood, near Belfast.*
1876. Feb. 14	Olden, Rev. Thomas, B.A. *Ballyclough Vicarage, Mallow, Co. Cork.*
1871. Apr. 10	O'Looney, Brian, F.R.H.S. *Grove-villa House, Crumlin, Co. Dublin.*
1861. June 10	*O'Mahony, Rev. Thaddeus, D.D. *Trinity College, Dublin.*
1884. May 12	O'Meagher, Joseph Cassimir. 49, *Mountjoy-square, Dublin.*
1882. Nov. 13	O'Reardon, John Frazer. 7, *Pembroke-road.*
1870. Jan. 10	§O'Reilly, Joseph P., C.E., Prof. of Mining and Mineralogy, Royal College of Science, Dublin, Secretary of Foreign Correspondence of the Academy. 58, *Park-avenue, Sandymount, Co. Dublin.*
1879. May 12	†O'Rorke, Very Rev. Terence, D.D., P.P. *Collooney, Sligo.*
1866. June 11	O'Rourke, Very Rev. (Canon) John, P.P. *St. Mary's, Maynooth.*
1838. Dec. 10	*Orpen, John Herbert, LL.D. 58, *Stephen's-green, East, Dublin.*
1870. Feb. 14	O'Shaughnessy, Mark S., LL.D., F.R.S.L., Regius Prof. of English Law, Queen's College, Cork. 27, *St. Patrick's-hill, Cork.*
1866. Jan. 8	O'Sullivan, Daniel, Ph. D. *Rosemount, North Circular-road, Dublin.*

Date of Election.	
1839. June 10	*Parker, Alexander, J.P. 46, *Upper Rathmines, Co. Dublin.*
1873. Feb. 10.	Patterson, William Hugh. *Garranard, Strand-town, Co. Down.*
1884. Feb. 11	Pearsall, William Booth, F.R.C.S.I. 13, *Upper Merrion-street, Dublin.*
1847. Feb. 8	*†Pereira [elected as Tibbs], Rev. Henry Wall, M.A., F.S.A. Scot. *Sutton Wick, Abingdon.*
1872. Apr. 8	Phayre, Major-General Sir Arthur Purves, K.C.S.I., G.C.M.G., C.B. *Bray, Co. Wicklow.*
1863. Apr. 13	Pigot, David R., M.A., Master, Court of Exchequer. a Vice-President of the Academy. *Churchtown House, Dundrum, Co. Dublin.*
1870. Apr. 11	Pigot, Thomas F., C.E., Prof. of Descriptive Geometry, Royal College of Science, Dublin. 4, *Wellington-road, Dublin.*
1838. Feb. 12	*Pim, George, J.P. *Brennanstown, Cabinteely, Co. Dublin.*
1849. Jan. 8	*Pim, Jonathan. *Greenbank, Monkstown, Co. Dublin.*
1884. Feb. 11	Plunkett, George Noble, Count of the Roman States, 14, *Palmerston-road, Rathmines.*
1880. Feb. 9	Plunkett, Thomas, F.R.G.S.I. *Enniskillen.*
1864. Jan. 11	*†*Poore, Major Robert.*
1862. Apr. 14	*Porte, George. 43, *Great Brunswick-street, Dublin.*
1873. Jan. 13	*Porter, Alexander, M.D., F.R.C.S., Assist.-Surgeon, Indian Army. *Madras.*
1875. Jan. 11	†Porter, Sir George Hornidge, M.D., M.Ch., Surgeon in Ordinary to the Queen in Ireland. 3, *Merrion-square, North, Dublin.*
1852. Apr. 12	**Porter, Henry J. Ker.*
1873. Jan. 13	Powell, George Denniston, M.D., L.R.C.S.I. 76, *Upper Leeson-street, Dublin.*
1864. June 13	†Power, Sir Alfred, K.C.B., M.A. 35, *Raglan-road, Dublin.*
1875. April 12	*†Powerscourt, Right Hon. Mervyn Wingfield, Viscount, K.P. *Powerscourt, Enniskerry, Bray.*
1854. Jan. 9	Pratt, James Butler, C.E. *Drumsna, Co. Leitrim.*
1874. Dec. 14	*†Purcell, Mathew John. *Stephen's-green Club, Dublin.*
1858. Jan. 11	Purser, John, M.A., D.Sc., Professor of Mathematics. *Queen's College, Belfast.*
1881. Apr. 11	*Quinlan, Francis John Boxwell, B.A., M.D., F.K.Q.C.P.I. 29 *Lower Fitzwilliam-street, Dublin.*
1884. May 12	†Ramsay, Edward P., F.L.S., C.M.Z.S., Curator of the Australian Museum. *Sydney, Australia.*

Date of Election.	
1867. Jan. 14	*†Read, John M., General, U.S. Army; Consul-General of the U. S. A. for France and Algeria, Member of American Philoso. Soc., Fellow of the Royal Soc. of Northern Antiquaries. *Athens.*
1846. Dec. 14	*§Reeves, Very Rev. William, D.D,. M.B., LL.D., Dean of Armagh. *The Public Library, Armagh*; *Rectory, Tynan.*
1843. Feb. 13	*§*Renny, Henry L., F.R.G.S.I., late Lieut. R.E.*
1878. June 24	*Reynell, Rev. William A., B.D. 8, *Henrietta-street, Dublin.*
1875. Jan. 11	*Reynolds, James Emerson, M.D., F.R.S., Professor of Chemistry, Dublin University. 62, *Morehampton-road, Donnybrook, Co. Dublin.*
1883. June 11	†Reynolds, Rev. R., C.C. *Monaseed, Gorey.*
1875. June 14	Robertson, John C., L.K.Q.C.P.I., M.R.C.S.L., F.R.A.S. *The Asylum, Monaghan.*
1881. Jan. 10	Robinson, John L., C.E. M.R.I.A.I. *Rathruadh, Glenagary, Co. Dublin.*
1844. June 10	*Roe, Henry, M.A. *Isle of Man.*
1876. Jan. 10	*†Ross, Rev. William. *Chapel Hill House, Rothesay.*
1870. Nov. 30	Rosse, Right Hon. Lawrence, Earl of, D.C.L., D.L., F.R.S. F.R.A.S. *Birr Castle, Parsonstown.*
1843. Jan. 9	*§Salmon, Rev. George, D.D. (Dub. and Edin.), D.C.L. (Oxon.), LL.D. (Cantab.), F.R.S., and Royal Medalist, 1868, Regius Professor of Divinity, Dublin University. 81, *Wellington-road, Dublin.*
1853. Jan. 10	*Sanders, Gilbert. *Albany Grove, Monkstown, Co. Dublin.*
1851. May 12	*Sayers, Rev. Johnston Bridges, LL.D. *Velore, Madras.*
1846. Feb. 9	*†Sherrard, James Corry. 7, *Oxford-square, Hyde-park, London.*
1869. Apr. 12	Sigerson, George, M.D., M.Ch., F.L.S., Prof. of Botany, Catholic University. 3, *Clare-street, Dublin.*
1835. Feb. 23	*§Smith, Aquilla, M.D., F.K.Q.C.P.I. 121, *Lower Baggot-street, Dublin.*
1877. Dec. 10	*†Smith, Charles. *Barrow-in-Furness.*
1868. Jan. 13	†Smith, John Chaloner, C.E., *Engineer's Office, Dublin, Wicklow, and Wexford Railway, Bray.*
1833. Apr. 22	*Smith, Joseph Huband, M.A.
1876. June 26	Smith, Rev. Richard Travers (Canon), B.D. *The Vicarage, Clyde-road, Dublin.*
1873. Jan. 13	Smyth, Patrick James, M.P., Chev. L. H. 15, *Belgrave-square, East, Rathmines, Co. Dublin.*

Date of Election.	
1867. Jan. 14	Smythe, William Barlow, M.A., D.L. *Barbavilla House, Collinstown, Killucan; National Club, 1, Whitehall Gardens, London.*
1873. April 14	*Smythe, William James, Lieutenant-General, R.A., F.R.S. *Coole Glebe, Carnmoney, Belfast.*
1874. Dec. 14	Stewart, James, M.A. (Cantab.), Professor of Greek and Latin, Catholic University. 21, *Gardiner's-place, Dublin.*
1871. June 12	§Stokes, Whitley, LL.D., C.S.I.
1874. June 22	Stokes, William, M.D., M. Ch. 5, *Merrion-square, North, Dublin.*
1857. June 8	*§Stoney, Bindon B., M.A., C.E., F.R.S., F.R.G.S.I., 14, *Elgin-road, Dublin.*
1856. Apr. 14	*§Stoney, George Johnstone, M.A., D.Sc., F.R.S., 3, *Palmerston-park, Upper Rathmines.*
1857. Aug. 24	*Sullivan, William Kirby, Ph.D., President of Queen's College, Cork. *Queen's College, Cork.*
1874 Apr. 13	†Sweetman, H. S. 38, *Alexandra-road, St. John's Wood, London, N. W.*
1871. Jan. 9	†Symons, John. 72, *Queen-street, Hull.*
1877. April 9	§Tarleton, Francis Alexander, LL.D., F.T.C.D., a Vice-President of the Academy. 24, *Upper Leeson-street, Dublin.*
1869. Apr. 12	§Tichborne, Charles Roger C., Ph.D., F.C.S. 15, *North Great George's-street, Dublin.*
1864. Mar. 16	Trench, Right Hon. and Most Rev. Richard Chenevix, D.D., Lord Archbishop of Dublin, Primate of Ireland. *The Palace, Stephen's-green, North, Dublin.*
1879. June 9	*Tucker, Stephen Isaacson. *Somerset Herald. Heralds' College, London, E.C.*
1846. Feb. 9	*Tuffnell, Thomas Joliffe, F R.C.S.I., M.R.C.S.E. 58, *Lower Mount-street, Dublin.*
1871. June 12	†Tyrrell, Colonel Frederick, J.P. *Gold Coast Colony, Accra, care of Forbes & Co., 25, Cockspur-street, London, S.W.*
1876. April 10	*†Tyrrell, George Gerald, Clerk of the Crown, Co. Armagh. 30, *Upper Pembroke-street, Dublin; Banbridge, Co. Down.*
1870. Nov. 30	†Ventry, Right Hon. Dayrolles Blakeney, Baron, D.L. *Burnham-house, Dingle, Co. Kerry.*
1880. Feb. 9	†Vesey, Agmondisham B., L.K.Q.C.P.I. *Bellevue, Magherafelt.*

Date of Election.	
1884. May 12	†Walsh, Very Rev. William J., D.D., President, St. Patrick's College. *Maynooth.*
1881. Feb. 14	*Ward, Francis Davis, J.P., *Clonaver, Strandtown, Co. Down.*
1864. Feb. 8	*†Warren, James W., M.A. 39, *Rutland-square, West, Dublin.*
1881. Jan. 10	*†Watts, Robert George, M.D., F.R.S.L., 5, *Bulstrode-street, Cavendish-square, London, W.*
1866. Apr. 9	Westropp, W. H. Stacpoole, L.R.C.S.I., F.R.G.S.I., *Lisdoonvarna, Co. Clare.*
1876. Nov. 13	†White, Rev. Hill Wilson, LL.D., *Wilson's Hospital, Multifarnham, Co. Westmeath.*
1880. Feb. 9	*White, John Newsom. *Rocklands, Waterford.*
1857. June 8	*†Whitehead, James, M.D., F.R.C.S.E., M.R.C. Phys., Lon. 87, *Mosley-street, Manchester.*
1851. Jan. 13	*†Whittle, Ewing, M.D., M.R.C.S.E. 1, *Parliament-terrace, Liverpool.*
1874. June 8	Wigham, John R. 35, *Capel-street, Dublin.*
1873. April 14	Wilkinson, Thomas. *Enniscorthy, Co. Wexford.*
1839. Jan. 14	*Williams, Richard Palmer, F.R.G.S.I. 38, *Dame-street., Dublin.*
1837. Jan. 9	*Williams, Thomas. 38, *Dame-street, Dublin.*
1877. April 9	Williamson, Benjamin, M.A., F.R.S., F.T.C.D. Professor of Natural Philosophy, Dublin University. 1, *Dartmouth-road, Dublin.*
1884. May 12	†Wood-Martin, Lieutenant-Colonel William Gregory, J.P. *Cleveragh, Sligo.*
1857. Aug. 24	*§Wright, Edward Perceval, M.A., M.D. (Dub.), M.A. (Oxon.), F.L.S., F.R.C.S.I., J.P., Professor of of Botany and Keeper of the Herbarium, Dublin University, Secretary of the Academy. 17, *Raglan-road, Dublin.*

HONORARY MEMBERS.

Date of Election.	
1863. June 22	HIS ROYAL HIGHNESS ALBERT EDWARD, PRINCE OF WALES.

"*The* PRESIDENT OF THE ROYAL SOCIETY, AND EX-PRESIDENTS *of the same, are always considered Honorary Members of the Academy.*"—By-Laws, ii., 14.

1869. Mar. 16 (Elected Hon. Mem. in Sec. of Science originally.)	Hooker, Sir Joseph Dalton, M.D., K.C.B., F.R.S., D.C.L., LL.D., Director of the Royal Gardens, Kew, EX-PRESIDENT OF THE ROYAL SOCIETY. *Kew, London, W.*
1832. Nov. 30 (Elected Hon. Mem. in Sec. of Science originally.)	Airy, Sir George Biddell, K.C B., D.C.L., LL.D., EX-PRESIDENT OF THE ROYAL SOCIETY. *Playford, near Ipswich.*
1874. Mar. 16 (Elected Hon. Mem. in Sec. of Science originally.)	Huxley, Professor Thomas Henry, LL.D., PRESIDENT OF THE ROYAL SOCIETY. *London.*

SECTION OF SCIENCE.

[Limited to 30 Members, of whom one-half at least must be foreigners.]

1873. Mar. 15	Adams, John Couch, LL.D. (Dub.), F.R.S. and Copley Medalist, Director of the Observatory and Lowndesean Professor of Astronomy and Geometry in the University of Cambridge. *Observatory, Cambridge.*
1874. Mar. 16	Berthelot, Marcelin Pierre Eugène. *Boulevard Saint-Michel, 57, Paris.*
1875. Mar. 16	Bertrand, Joseph Louis François. *Paris.*
1869. Mar. 16	Brown-Séquard, Charles Edouard, M.D., F.R.S. *Collège de France, Rue Gay Lussac, Paris.*
1869. Mar. 16	Bunsen, Robert Wilhelm Eberard. *Heidelberg.*
1869. Mar. 16	Carus, J. Victor, Professor of Comparative Anatomy. *Leipzig.*
1873. Mar. 15	Cayley, Arthur, LL.D. (Dub.), F.R.S., Sadlerian Professor of Mathematics in the University of Cambridge. *Cambridge.*
1883. Mar. 16	Charcot, J. *Paris.*
1866. Mar. 16	Clausius, Rudolf Julius Emmanuel. *Zürich.*
1873. Mar. 15	Dana, James Dwight, LL.D., Professor of Geology and Mineralogy. *Yale College, New Haven, Conn., U. S. America.*

HONORARY MEMBERS—*Continued.*

SECTION OF SCIENCE—Continued.

Date of Election.	
1869. Mar. 16	Daubrée, Gabriel Auguste. *Ecole des Mines, Paris.*
1876. Mar. 16	Decandolle, Alphonse, Professor of Botany. *Geneva.*
1875. Mar. 16	Gray, Asa, Professor of Botany, Harvard University, *Cambridge, Massachusetts, U. S. America.*
1876. Mar. 16	Haeckel, Ernst, Professor of Zoology. *Jena.*
1864. Mar. 16	Helmholtz, Hermann Ludwig Ferdinand Von. *Berlin.*
1884. Mar. 16	Hermite, Charles. 2 *Rue de Sorbonne, Paris.*
1873. Mar. 15	Hofmann, August Wilhelm, F.R.S., Professor of Chemistry in the University. *Berlin.*
1879. Mar. 16	Huggins, William, D.C.L., LL.D., F.R.S. *Upper Tulse-hill, London, S.W.*
1864. Mar. 16	Hyrtl, Karl Joseph. *Vienna.*
1880. Mar. 16	Loomis, Elias. *Yale College, Conn., U. S. America.*
1880. Mar. 16	Marsh, O. C. *Yale College, Conn., U. S. America.*
1882. Mar. 16	Newcomb, Simon. *United States Naval Observatory, Washington.*
1884. Mar. 16	Nordenskjöld, Baron Adolf Erik de. *Stockholm.*
1878. Mar. 16	Pasteur, Louis. *Paris.*
1873. Mar. 15	Stokes, George Gabriel, D.C.L. (Oxon.), LL.D. (Dub.), Fellow and Secretary of the Royal Society, Lucasian Professor of Mathematics in the University of Cambridge. *Lensfield Cottage, Cambridge.*
1878. Mar. 16	Thomson, Sir William, LL.D., D.C.L. (Oxon.) F.R.S. *Glasgow.*
1882. Mar. 16	Virchow, Rudolph. *Berlin.*

(Three Vacancies.)

SECTION OF POLITE LITERATURE & ANTIQUITIES.

[Limited to 30 Members, of whom one-half at least must be foreigners.]

Elected in the Department of Polite Literature.

Date of Election.	
1869. Mar. 16	Gayangos y Arce, Don Pascual de. *London.*
1869. Mar. 16	Lassen, Christian. *Bonn.*
1849. Nov. 30	Lepsius, Karl Richard. *Berlin.*
1869. Mar. 16	Mommsen, Theodor. *Berlin.*
1863. Mar. 16	Müller, Max. *Oxford.*

Elected in the Department of Antiquities.

1869. Mar. 16	Benavides, Don Antonio. *Madrid.*
1848. Nov. 30	Botta, Paul Emile. *Paris.*
1867. Mar. 16	De Rossi, Commendatore Giovanni Battista. *Rome.*
1841. Mar. 16	Halliwell-Phillipps, James Orchard, F.R.S., F.SS.A. Lond. and Scotland., &c. *Hollingbury Copse, Brighton.*
1854. Mar. 16	Maury, Louis Ferdinand Alfred. *Paris.*
1867. Mar. 16	Visconti, Barone Commendatore P. E. *Rome.*
1867. Mar. 16	Worsaae, Hans Jakob Asmussen. *Copenhagen.*

Elected since the union of the two classes of Honorary Members in this Section.

1882. Mar. 16	Ascoli, Graziadio I. *Milan.*
1878. Mar. 16	Bradshaw, Henry, M.A., University Librarian, *Cambridge.*
1882. Mar. 16	Bond, Edward Augustus, LL.D., Principal Librarian of the British Museum. *London.*
1882. Mar. 16	Brugsch-Pascha, Heinrich. *Berlin.*
1878. Mar. 16	Curtius, Georg. *Leipzig.*
1883. Mar. 16	Evans, John, LL.D., D.C.L., Fellow and Treasurer Royal Society, *London.*
1875. Mar. 16	Franks, Augustus Wollaston, M.A., F.R.S., F.S.A. 103, *Victoria-street, London, S. W.*
1880. Mar. 16	Fick, F. C. August. *Göttingen.*
1878. Mar. 16	Kern, H. *Leyden.*
1882. Mar. 16	Maine, Sir Henry James Sumner, LL.D., K.C.S.I., F.R.S., Master of Trinity Hall, Cambridge. *Cambridge.*
1878. Mar. 16	Newton, Charles, C.B., D.C.L., F.S.A. *British Museum, London.*

Date of Election.	
1873. Mar. 15	Nigra, His Excellency Cavaliere Constantino, Italian Minister to Russia. *St. Petersburg.*
1884. Mar. 16	Stephens, George. *Copenhagen.*
1876. Mar. 16	Stokes, Margaret. *Carrig-Breac, Howth, Co. Dublin.*
1876. Mar. 16	Stubbs, Right Rev. William, D.D., Lord Bishop of Chester. *Chester.*
1873. Mar. 15	Westwood, John Obadiah, F.S.A., Hope Professor of Zoology, Oxford. *Oxford.*
1875. Mar. 16	Whitney, William Dwight. *Yale College, Conn. U.S., America.*
1876. Mar. 16	Windisch, Ernst. *Leipzig.*

SUMMARY.

Life Members	...	...	...	150
Annual Members	...	...	...	181
				331
Honorary Members (57 + 4)		...	...	61
		Total,	...	392

Should any errors or omissions be found in this List, which is revised to 26th May, 1884, it is requested that notice thereof may be given to the Secretary of the Academy. He should also be informed of the death of any Member.

R. D. Webb and Son, Printers, 74 Abbey-street, Dublin.

LIST

OF THE

COUNCIL AND OFFICERS

AND

MEMBERS

OF THE

ROYAL IRISH ACADEMY:

DUBLIN,

1st of July, 1886.

DUBLIN:
ACADEMY HOUSE, 19, DAWSON STREET.

1886